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[OFFICIAL NOTICE.]

New England Association of Gas Engineers.

The next semi-annual meeting and excursion of the members, with their ladies and friends, will be held on the 16th and 17th days of August, instant, according to the accompanying programme.

The headquarters of the Association will be at the Bancroft House, New Bedford, Mass.

Officers of gas companies, and gentlemen furnishing supplies and machinery to such companies, are hereby cordially invited to be present at the meeting and excursion without further invitation.

Those intending to be present at said meeting are earnestly requested to notify the Secretary, on or before August 12th, of such intention, and whether they wish rooms engaged.

PROGRAMME.

Wednesday, August 16.

8 A.M.—Leave Boston by Boston and Providence Railroad.
8:15 A.M.—Leave Boston by Old Colony Railroad.
10:30 A.M.—Arrive at New Bedford; short walk to Bancroft House.
11 A.M.—Business meeting.
1 P.M.—Dinner.
2 P.M.—Business meeting.
4 P.M.—Visit gas works, etc.
7 P.M.—Tea.

Thursday, August 17.

7:30 A.M.—Breakfast.
8:30 A.M.—Take steamer for Oak Bluffs, Martha's Vineyard.
10:30 A.M.—Arrive at Oak Bluffs.
12 M.—Dinner at Sea View House, Oak Bluffs.
1 P.M.—Take steamer for Gay Head and extended sail back to New Bedford, arriving at about 4 o'clock.
4:30 P.M.—Train leaves for Boston by Old Colony Railroad.

August 1, 1882.

GEO. B. NEAL,
Secretary.

A. B. SLATER,
H. A. ALLYN,
R. B. TABER,
GEO. B. NEAL,
Committee of Arrangements.

ELECTRIC LIGHTING ON OCEAN STEAMSHIPS.

There is probably no application of the electric light more advantageous, or more conducive to the security of those interested, than its adaptation to the uses of those immense steamers that are engaged in plying between this country and Europe. When we consider the large and increasing number of our people who cross and re-cross the ocean every summer, the large number of ships employed, and the immense size of some of them, safety becomes a consideration of the first importance; and it cannot be denied that the incandescent light has been so adapted to the requirements of the case as to give great relief from the danger which must ever attend the use of open lamps at sea.

There is no steamship as yet which relies entirely upon the electric system of lighting; but there are several that have introduced it to a greater or less extent, with a degree of success, so far as the lighting is concerned, that renders it worthy of notice and commendation.

The steamer Servia, of the Cunard line, is said to be the largest commercial steamer afloat, excepting the Great Eastern, being 530 feet in length, 52 feet beam, 40 feet 9 inches deep, and having a measurement of 8,500 tons. She is propelled by engines of 10,500 horse power, while her screw is 23 feet 6 inches in diameter. Thirty-nine boilers and furnaces, all told, supply the power for all purposes, and steam power is employed for every possible purpose, in order to reduce to the minimum the manual labor required. A large

portion of the ship is lighted by Swan's incandescent electric lamps. In outer appearance they differ practically in no respect from the Edison or Maxim lamps, being a similar glass bulb with the carbon filament within which is heated to incandescence by the passage of the electric current through it. In one respect the Swan light differs from either the Maxim or the Edison, viz., it is practically steady, and is free from any apparent pulsation or "squeezing," nor is it possible to detect any effect of pulsation when the illuminated surfaces of the room are carefully watched therefor. This same peculiarity was noticeable at the Paris Electrical Exhibition last summer. The method of putting on the bulbs is extremely simple. The current wires lead through a small wooden block, about an inch and a-half in diameter and four inches long, which is put into the ordinary lamp bracket in place of the oil lamp. These wires terminate just above the upper end of the block in hooks just inside a spiral spring attached to the wood. The wires passing into the bulb are also turned up in a hook at the lower end, just below the stem, so that all that is necessary to put a lamp in place is to place the stem of the bulb inside the spiral spring, press down gently and connect the hooks with each other, then the pressure of the spring maintains the wires in contact, and, at the same time permits a certain amount of motion laterally in any direction, which reduces somewhat the liability to breakage that would follow greater rigidity in the attachment.

There are on the Servia 140 lights which are distributed through the "stoke-hole," or furnace room, the engine-room, the ladies cabin, the main saloon, the smoking room, the music room, the officer's mess-room, etc., in two of the companion ways or staircases leading on deck from below. The candle power varies from six to fifteen candles, according to position where they are placed. The staterooms are generally lighted by the usual oil lamps in locked cases, so that perhaps about one-half the lighting of the ship is done by electricity. The lights in the stoke hole and engine room are 54 in number, and, of course, are in use day and night—the other lights being turned on at dark, when light is required in the saloons, etc., these latter being put out at 12 P.M. There are two cables leading from the dynamo-machine, one of 19 and one of 14 strands, these are subsequently divided into smaller cables by separating the strands, and led to the separate sections of the ship where the light is used, and the lights in any division may be extinguished by switching out the wires leading to it. The light is beautiful, steady and agreeable, and the saloons are certainly better lighted than is usual with oil lamps. The current is furnished by two Siemens machines, one large one and one small one used as an exciter. These are driven by a Brotherhood three-cylinder engine, of sixteen horse power, which runs at 640 revolutions when the 140 lights are in use, and at 550 revolutions when the 54 lights used day and night are being employed. The number of revolutions is varied somewhat from time to time, according to the temperature of the room where the machines are placed, and resistance coils, placed near the machines, are used to regulate the strength of the currents as different portions of the lights are put on or off. The steam for the engine is furnished direct from the ship's boilers, and is at the same pressure as that used in the ship's engines.

The outfit, therefore, consists of the Brotherhood engine, the two dynamos, about three miles of wire, and the lamps themselves. The average number of lamps that are broken or get out of order is 15 or 16 out of the 140 during each round trip.

The price at which the Swan lights are sold at retail in England is five shillings ($1.25) each; but it is natural to suppose that there is a discount from this price to regular consumers.

As to the cost of the light it is somewhat difficult to arrive at any definite information; but the fact appears that with "sixteen-horse power" applied at the dynamos, there are 140 lights, with an average candle power of from 10 to twelve candles each, or about one hundred candles of light for each horse power expended.

|Communicated Article.|

Firing with Hot Coke.

By Eta.

It is indeed strange that the matter of charging the retort furnaces with red-hot coke, as drawn from the retorts, has made so little progress, not only in the gas works throughout this country but in Europe as well. Small as is the advance we have made in this regard, we lead our trans-Atlantic friends. Whenever the subject has been discussed, whether here or abroad, it has been particularly noticeable that the disputants on either side have been able to advance little in the way of absolute data bearing on the question. In fact the matter has usually been treated in a general way, mainly on account of the lack of any practical experiments having been made which would show conclusively whether the economy of fuel, labor, etc., were for or against the hot coke method.

In regard to the fuel account this void has now been well filled by the experiments made by Mr. Combe, of the 14th street station of the Manhattan company, and which were communicated to the Society of Gas Lighting at their May meeting. Now, we know of a surety, what before we only knew by presumption, namely, that there is a saving in fuel, and a large one, in favor of the hot coke method. Taking the average of the five experiments made by Mr. Combe we find that, with cold coke, 2,350 lbs. were used in 24 hours; while, when it was charged hot direct from the retorts, only 2,000 pounds were needed during the same period. This is a reduction in the coke used of 6.8 per cent. of the amount made, or 14.9 per cent. of the quantity used when it was charged cold, or, putting it more plainly, the coke consumed in the hot coke furnaces was only about 85 per cent. of that used in the cold coke furnaces. When we try to reason out how this result is obtained it would seem at first that the whole gain was simply in the amount of heat which is taken to bring up the temperature of the cold coke to that of the coke as drawn from the retorts.

In fact, this is the commonly held opinion that the number of heat units consumed in raising the teperature of the coke to, say, 2,100°F. divided by the number of heat units derived from the combustion of a pound of coke as obtained in retort furnaces would be the number of pounds of this fuel saved by charging it hot; but we will see that we must look further than this.

It will be noted that in the trials alluded to the results are all reduced to pounds, the bushel being discarded; undoubtedly the measure is an unreliable standard, and the substitution of weight a desirable change. On the other hand, coke quenched with water is thereby materially increased in weight; it will, therefore, be necessary to make allowance for the moisture. We will assume that the moisture will weigh three per cent. of the total weight of the coke. This will change the figures with respect to the coke made and used, but will not alter the percentages of the coke made reckoned on a basis of the total make. To arrive at the coke used in the hot coke furnace it was necessary to assume that the quantity made in this bench was the same as that produced in the cold coke bench. Then deducting the weight left over from the coke made, the remainder was the quantity used. Thus the coke made, including moisture, weighed 5,155 pounds. The weight of that left over was 3,155 pounds, leaving 2,000 pounds used in the furnace. Now it is plain that if we allow for the moisture of the coke, we will change all these figures.

To make it plain we will deduct three per cent. in weight for the moisture and put the results in tabular form—

Coke made and used, less three per cent. for Moisture.

Coke made, in pounds.	Coke used, in pounds.	Per Cent. of Coke used per 100 lbs. coal carbonized.
5000	2280	30.35 Cold.
5000	1939	25.80 Hot.
	241	

Having now reduced the weights to those of dry coke, let us proceed to calculate whether the saving of 241 pounds of coke will approximately equal the quantity required to raise the cold coke to the temperature of that drawn from the retorts. As opinions may differ relative to the value to be assigned to the various factors, the answer will be open to the same criticism, but we can certainly arrive at an approximately correct result. The temperature of the coke as drawn from the retorts we will assume to be 2100°F., while cold coke will be placed at 70°. The efficiency of the coke as used in the common furnace will have to be put at 30 per cent. of its theoretical power; that will be 4350 heat units. Finally, we will take .2 as the specific heat of coke, compared with water as 1. The following will therefore give us the coke used in raising the temperature of the cold fuel used in 24 hours to 2100°F.:

$$\frac{\text{Pounds of coke} \quad \text{Degrees raised} \quad \text{Specific heat}}{\text{4350 available heat units of 1 lb. coke}} = \frac{2280 \quad 2030 \quad .2}{\text{4350 available heat units of 1 lb. coke}} = 213 \text{ pounds.}$$

That is, on the basis of the values we have assumed, 213 pounds of coke are required to raise the temperature of the coke from 70° to 2100°F. The result is, as foreshadowed, below the figure obtained in practice. In explanation of this apparent discrepancy we would again revert to the moisture in the coke. According to our figures there were 70 pounds of water charged into the furnace during the 24 hours along with the coke when the latter was used in the cold state. Now it is usual to assume that this water does no harm, that the heat absorbed in vaporizing it is given out by the burning hydrogen. Of this we have grave doubts. It is possible that the steam generated in the lower portion of the coke is broken up, and that the resulting hydrogen is consumed; but it would seem probable that the steam produced at the upper part of the fuel passes off in that form, as it comes in contact with little or no incandescent carbon. In fact we would incline to the opinion that full 50 of the 70 pounds of water goes off as steam; if this be so, then to vaporize the 50 pounds of water from 70°F. will require 12.73 lbs. of coke.

To recapitulate—we found from the experiments of Mr. Combe that, after allowing for moisture, 241 pounds of coke were saved by the use of hot coke; we have accounted for 213 pounds by the heat required in raising the coke to

2100°F., and 12.73 pounds by the water vaporized, making together 235.73 pounds, leaving the practical result 5½ pounds over the theoretical. This difference would vanish if we took for granted that none of the steam in the coke was dissociated. As the factors of the theoretical case are open to criticism, it would be idle to attempt to discover some evil against which to charge the five pounds of fuel. Aside from the economy in fuel and labor, firing with hot coke must commend itself because by its aid a more even heat can be maintained.

The Petroleum Outlook.

The changes which have taken place up to the date of June 20th, have been greater and more startling than any that have occurred in a like period for many years. The well on lot No. 646, in Warren county, to which we referred in our last issue, has proved to be far more important than was at first supposed. When its capacity was tested it turned out to be a twelve hundred barrel well, and was the forerunner of several which came in still larger. The two wells of the Anker Oil Company, both lying a little to the west of 646, within four or five hundred feet of it, opened within the past four weeks, started off at about twenty-five hundred barrels each, while the Murphy well three-quarters of a mile northeast from 646 also came in as a producer of fifteen hundred barrels. The Mahoopany well lying still further to the northeast exhibits more gas and less oil, but will probably develop into a producer of like capacity as the others. Thus within the past six weeks we have had precipitated upon us what may be regarded as an entirely new field, and one which promises to give us considerable oil to add to our stocks.

There are some considerations, however, which tend somewhat to relieve the apprehensions of the holders of oil. Among these are the following :

1. The present very low market prices for crude (ranging near 52½ cents per barrel) paralyzes the energy of the producers in the Bradford and Richburg fields, inasmuch as producing at this price in those fields is undoubtedly below the remuneration point ; and consequently operations there are rapidly coming to a stand still. Indeed, so discouraging seems the prospect there that some of the wells which, two months ago, were yielding profit to the owners, are now abandoned.

2. The uniform experience of operators in this business has been, that large flowing wells, such as the Warren field at present affords, indicate a narrow belt of limited length, and a short life to the wells. The Pithole development of 1866 and the Bullion development of 1877 were among the more conspicuous of the illustrations of this experience, and it is not to be expected that Warren will prove an exception.

3. It is not unlikely that the falling off of production resulting from the inaction of Bradford and Richburg will more than overcome the increase which will come from Warren.

4. In the present very plethoric condition of the money market, it is hardly probable that prices can remain so low as they are now, especially if Warren should begin to show a limitation of area or a falling off in yield of the "gushers."

5. The season for heavy export and large demand from the home trade, is almost upon us and judging from all the indications in view, the output from the regions, during the months of July, August, September, October and November will be unprecedentedly large.

Altogether, while we do not at present see any reason for a large advance within the next forty days, we are of opinion that the present, exceptionally low price, is slowly but surely working a remedy, the benefits of which the conservative holder of oil will be able to realize before the completion of this year.

As quite a number of wells in the Richburg and Bradford fields were started several months ago (before the discovery of the Warren field,) the statistics of drilling wells and wells completed for the past month, does not show a great decline. In this report for the months following this, however, that falling-off will become apparent.—Stowell's *Petroleum Reporter*.

Regnard's Incandescent Lamp.

A late Number of *La Nature* devotes considerable space to the subject of the necessity of a process for obtaining a bright light which should permit of projections being easily made in cases where neither gas nor electricity are obtainable. It makes the claim that this want is very cleverly supplied in the invention of Dr. Regnard, which it thus describes—

"There has for a long time been sought a process for obtaining a bright light which should permit of projections being easily made. In places where electric lights exist the thing is very simple, and it is also easy in places where there is gas, but then oxygen being necessary the apparatus became quite difficult to arrange and move about. But in all localities where even gas does not exist it becomes absolutely necessary to dispense with a method of teaching which, it is generally agreed, is an excellent one.

"Quite recently the Minister of Public Instruction requested a special commission to design for him an apparatus that might readily be used in primary schools for making projections. The result of this commission's examination is that even if simple apparatus for projection be not wanting, we are very far from having luminous foci sufficiently intense for obtaining somewhat enlarged images.

"Dr. Regnard has conceived the idea of obtaining a very brilliant light by burning a mixture of air and vapor of petroleum on a platinum gauze. There results from this an intense heat, which raises the platinum wires to a white heat, and thus produces a light about half as bright as that of the oxyhydrogen light. The apparatus is very simple, consisting of an ordinary Bunsen burner terminating in a little cage of platinum wire. Instead of supplying this burner with gas, there is forced into it a mixture of air and petroleum vapor, according to a process known for a long time, and utilized recently by the numerous inventors of thermo-cauters. A simple kitchen bellows or a syringe bulb is quite sufficient to set up the necessary current of air. In order to throw all the light in one direction the Bunsen burner may be covered with a tube having a flaring orifice, like the bell of a trumpet, covered very accurately with a network of platinum wire. In order to obtain an extremely brilliant light whenever the blowing is done, it is only necessary to regulate the flow of the gaseous mixture by the ring of the burner. If, instead of using a bellows, the current of air be forced by a pneumatic machine or tromp, quite a number of lamps may be supplied and made to give a light having the aspect and power of incandescent electric lamps for rooms, factories, etc., in places where no gas exists.

"Dr. Regnard's lamp is based on the Bourboze burner, but is superior to that in not requiring the use of illuminating gas. It has another very great advantage, and that is that it costs almost nothing, and even when operating at a maximum the expense is only a few cents per hour. It will prove of service to physicians for making laryngoscopic and otoscopic examinations.

"If it be desired to give the apparatus greater constancy and make it serviceable for regular lighting, we suppose it would be necessary to go to a little more expense and increase the size of the carburetter in order that the impoverishment of the petroleum may not make itself too quickly felt. This may be accomplished by causing the air to bubble through one of those large flasks found in all drug stores, and into which there will be put nine or ten pints of the liquid. Such a flask may be placed under the table holding the apparatus, or even further off.

"If it be not desirable to perform the blowing with the hands, there may be disposed under the table a large blowing apparatus that any one can construct by loading with a weight a bag filled with air. If the bag is tolerably large the lamp will be enabled to operate for several hours without any attention being paid to it. The petroleum product to be put into the carburetter is the ordinary benzine of commerce."

Large Exhausting Plant.

The most extensive exhausting plant ever erected is, perhaps, that put up by Messrs. Donkin and Company, at the Beckton Works of the Gas Light and Coke Company. This plant is all in one exhauster-house, and comprises eight exhausters each to pass 250,000 cubic feet per hour, making the total quantity per diem 48 millions of cubic feet. Each pair of exhausters is driven by one of Messrs. Donkin's 40-horse power nominal steam-engines, coupled direct by two universal couplings, and the slides of the exhausters are set at right angles with each other to insure a more regular flow of gas.

The object of this fine exhausting plant is to pump pure gas from the holders at Beckton, through four feet mains to the distributing stations in London, a distance of from eight to ten miles. The exhausters work with perfect regularity and success. This machinery is made use of only during the dark months of the year, as in the lighter months, when the demand is much less and the pressure not required, the gas flows through the mains without any pumping.

Reduced Price for Gas in Nashua, N. H.

The Nashua Gas Company announces another reduction in price, which makes the seventh reduction under the present management since 1872. In this period the successive reductions have been from $3.80 to $2.10. The Nashua *Daily Telegraph*, of July 18th, in making mention of the reduction, comments as follows :

"Here is one corporation that is managed on the broad principle that the public are entitled to all the advantage beyond a reasonable dividend. Mr. W. D. Caldwell is the Treasurer, and Mr. A. M. Norton, Superintendent ; but all other places are notified that they are not to let."

ALLOY FOR FILLING HOLES IN IRON.—Lead, 9 ; antimony, 2 ; bismuth, 2. This alloy expands in cooling, and sets almost instantly.

[From the London "Journal of Gas Lighting"]

The Principles of Gasholder Construction.

A paper read by Mr. George Livesey, M.I.C.E., at the meeting of the Gas Institute, Birmingham, Eng., on Tuesday, June 13, 1882, with the discussion thereon.

A "gasholder," as the term is understood, is something more than a mere receptacle for the storage of gas. It furnishes the pressure required for distribution, and it acts as a regulator between the uniform rate of production, during the 24 hours, and the extremely fluctuating rate of consumption. Not only on these grounds, but also on account of so large a proportion of capital being absorbed in their construction, and the fact that, from an engineering point of view, they are the most important portion of gas works plant, gasholders claim the earnest attention of engineers.

Taking the typical £5 of capital per ton of coal, it will be found that after deducting £2, in round numbers, for distributing plant and working capital, of the £3 left for the construction of manufacturing plant, £1 (or just about one-third) will be required for gasholders, assuming them to cost £20 per 1,000 cubic feet capacity, which is a reasonable and usual figure for moderate sizes.

To no portion of gas works plant may accidents happen with impunity; but serious accidents to gasholders produce the greatest amount of loss and inconvenience, and even small irregularities cause great anxiety. It is therefore essential, for comfortable working and the regular supply of gas, that gasholders should work, automatically, with strict regularity at all times; and for this purpose it is essential that they be maintained perfectly level. Some of the worst accidents to gasholders have been the result of tilting, caused possibly by an accumulation of snow on one side of the crown, or by overfilling both tank and gasholder, when a gust of wind—acting on a holder and framing not fitted so truly and well as they ought to be—has caused the bottom curb to lodge on the edge of the tank, and has resulted in the fracture of the guide columns and the collapse of the holder.

As in none but the very smallest undertakings can it be considered advisable to work with only one gasholder, vessels are wanted that shall be gas-tight, strong, and durable, economical in construction and dependable in working, and, as far as human foresight can ensure it, with no tendency or liability to irregularities or accidents, and of sufficient weight to give the necessary pressure.

The main difference between gasholders of the present day and those of forty or fifty years ago is the great increase in capacity. The pioneers of the gas industry, in this as in so many other matters, devised machinery that was so admirably adapted for its purpose—particularly exemplified in the case of gasholders—that we are compelled to follow very closely the principles they laid down. All that we have been able to do has been to modify and adapt those principles to modern requirements—to gasholders whose contents are counted in millions instead of tens of thousands of feet. For instance, at the Old Kent Road works in 1840 there were three single-lift gasholders of 30,000, 30,000, and 40,000 cubic feet capacity respectively, and one double-lift (having a guide framing admirably constructed of timber) with a capacity of 44,000 feet; whereas now the largest holder contains more millions than the largest in those days did ten thousands. It would, in fact, require 125 times the contents of the largest holder of 1840 to fill the largest holder of 1882.

In designing a gasholder—of course of the usual cylindrical form—the first consideration, having settled the capacity, is to determine the diameter, depth, and number of lifts whereby the amount of storage can be most conveniently and economically obtained. The question of pressure being attended to, the details have to be dealt with—such as the sheeting of the sides and crown, the form and strength of the crown curb, the vertical stays or stiffeners, the arrangement for guiding the holder in the guide framing, and last, but by no means least in importance, the system of guide framing to be adopted.

Capacity of Gasholders.

Owing mainly to the great increase in the demand for gas, but partly to an extraordinary fear of large holders, there are to be found at the majority of gas works a series of wretchedly small and most inconveniently placed holders. It appears to have been a cardinal principle, in designing gasholders, not to make them large; but when, on rare occasions, exceptionally large holders have been constructed, and have, as a matter of course, been found to work well, one never hears a complaint that they are too large, though complaints about small holders (which, as a rule, are far more troublesome in working than large ones) are rife.

In designing entirely new works for the supply of a district, not more than two holders, of about equal size, should be provided; their united contents being not less than the maximum day's make. In making additions to the storage of existing works, it will not be found far wrong if the contents of the new holder are made equal, or nearly equal, to the total existing storage. For instance, if with a make of 700,000 cubic feet per day the storage amounts to 500,000 feet, the new holder may have a capacity of 500,000 feet. This will be in excess of immediate requirements; but seeing that, by increasing the capacity, the proportionate cost is reduced, it will be found in the end to be advantageous. There are, of course, limits to this rule, which have in some cases probably been reached, as at the Old Kent Road, where with seven gasholders whose united capacity amounted to 5¾ millions, the last addition of 5¾ millions brings up the total to 11½ millions; though our highly esteemed Past-President, Mr. Hunt, is now engaged on a pair of holders of equal size, the united capacity of which will be nearly 13 millions. I heartily wish him all the success in these magnificent structures which he justly deserves.

As the tank forms so large a proportion of the cost of a gasholder, single-lifts, except for the smallest holders, of less than 10,000 feet, should be avoided. Moreover, to ensure steady working, gasholders must not be too shallow. If the depth to the diameter is in the proportion once forciby described to me as corresponding to the rim of a frying pan to its bottom, the holder will be very liable to tilt. I have for years followed the rule of 4 to 1—that is, for a diameter of 100 feet the depth of the side would be, say, 25 feet, giving a rise of about 50 feet for a double holder—and have never known such holders to show any tendency to tilt.

The expense of the tank is also an argument against holders with less than three lifts, except for moderate capacities of, say, under 500,000 feet; but where this amount of storage is required, it will probably be found cheaper to construct a three-lift holder.

The pressure usually given by the inner lift is quite sufficient; but when very great pressure is needed, instead of the heavy cast iron weights that have sometimes been fixed inside the holder for this purpose, it would be much better to increase the substance of those parts which are the first to wear out—viz., the sheets and the cup. Generally, however, the object will be to diminish rather than increase the weight.

Sheeting.

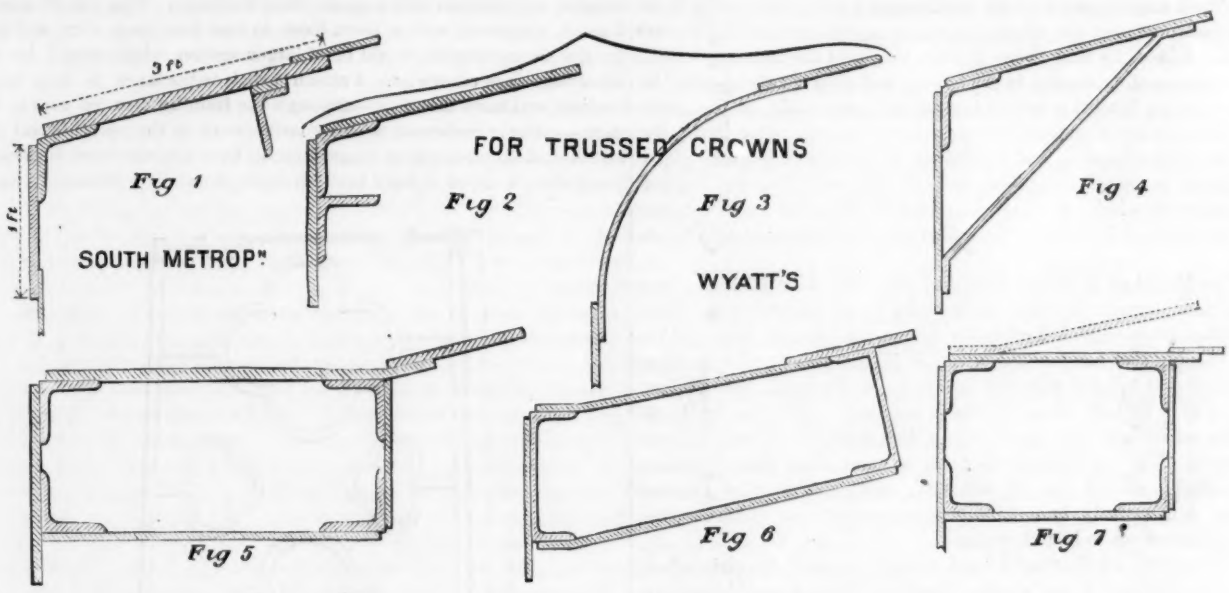
As on the sides the pressure in any case exerts no appreciable strain, and the suspended weight they have to carry never approaches the safe load, there is no reason for breaking joint, which would cause considerable inconvenience in erecting. The thickness of the sheets may therefore be governed solely by the question of durability; but the size usually adopted, of 4 ft. by 2 ft., has in some cases been increased with advantage. An alteration in the size, however, may involve alterations in the machinery of the gasholder builders, which would for a time neutralize the economy; but a reduction in the number of joints and rivets should reduce the liability to leakage and the cost.

The crown sheets are subjected to a heavy tensile strain in exact proportion to the rise given to the crown. For instance, if with a rise of, say, 5 feet, the strain on a given section of the sheeting equals one ton, by increasing the rise to 10 feet the strain will be reduced one-half, or to half a ton. As, however, there are limits to the amount of rise, it is advisable to break joint in the sheeting, and as this increase in the strength is accompanied by the economy of using something like 96 per cent. of square sheets, which can be entirely punched at the works by the multiple press, the plan ought to come into general use. The sheets ought to be of uniform thickness, as the strain is uniform. Radiating strips of thicker plate are unnecessary and, I think, objectionable. The usual practice with trussed crowns has been to give a rise equal to 1-20th of the diameter in the form of a segment of a sphere; but some untrussed crowns have been made flat, and hence the name "flat tops." This may do for small holders, but it is quite inadmissible for the large ones of the present day, as thereby the tension of the sheeting and the compression of the curb become most excessive, rendering the crown liable to rip and the curb to buckle. Better plans now prevail. A rise equal to 1-15th of the diameter is sometimes given, and even this may with advantage be exceeded. With a rise equal to 1-20th, sheets of No. 11 gauge are sufficient for gasholders of moderate size; but for the very large ones, of about 200 feet diameter, it is better to use No. 10 gauge sheets, and to give rather more rise to the crown. The crown sheets should have 5-16th inch rivets.

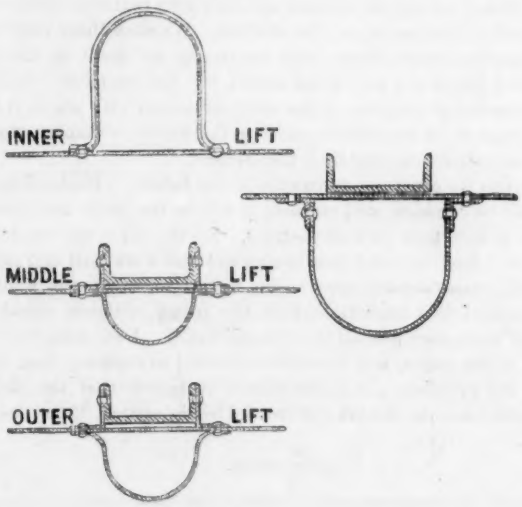
Trussing or Non-Trussing.

Trussed crowns received their sentence of condemnation at the hands of Mr. Geo. Anderson, who, in his usual forcible and effective manner, dealt with the question in his paper, and the resulting discussion at the meeting of the Association in 1868. Trussing has been proved to be unnecessary, and, in the case of large holders, more expensive than the substituted timber framing in the tank and the increased strength of the crown curb; besides adding to the weight and pressure of the holder. But for small holders it may be advisable to truss the crown where weight is wanted and the trussing is simple and inexpensive.

The *crown curb* in trussed holders needs very little consideration; but where trussing is dispensed with, this is one of the most important members



of a gasholder. Many forms of curb have been made and proposed— a few are here illustrated—but the choice seems to lie between some form of box girder and the simple angle for non-trussed crowns. The curb, being under severe compression, must have a sufficiency of metal, which for small holders may be obtained in a single angle-iron ; and where this is the case there can be no question as to its adoption, because it gives the strength at the *exact spot* where the strain comes, and it is in addition the cheapest and the easiest to work. If, for large holders, angle-iron or angle-steel of sufficient section could be obtained, the same reasons for its use would apply with equal force; but when the compressive stress amounts to 200 tons or upward, requiring 40 or 50 inches of solid iron, single angles are out of the question. The principle, however, can be adhered to as shown in fig. 1 of the drawing, which differs only from that described by Mr. Anderson in 1868 by the addition of the inner angle, and the use of steel instead of iron. It consists of an angle steel and thick steel plates, with an angle on the inner edge of the wide top plate to keep it from buckling. The sole reason for using steel is its greater power to resist compression. The curb was adopted for the large holder after considering a great variety of forms, because every inch of section can be kept fully up to its work ; while it is at the same time the easiest and simplest to construct, and withal the cheapest.



Vertical stays or stiffeners in shallow holders are of comparatively little importance. A simple T or channel iron answers the purpose; but when depths of 40 feet are reached something more is necessary. Thick strips of plate forming part of the stiffeners in the sides of the holder are totally useless, as, besides increasing the cost, they interfere with the uniformity of the sides, and cause the sheets to buckle. The best form of stiffener, in my opinion, is the D-shaped, introduced some years ago, but by whom I do not know. It consisted of a thick vertical plate, to which was attached, by means of two angle-irons, a U-shaped plate. The thick vertical plate is useless and injurious, and so are the angle-irons, and the U-shaped plate was made needlessly thick ; thus altogether detrimentally increasing the weight and the cost. The modified form of this stiffener, which I have found to work perfectly, consists simply of the ordinary No. 10 or No. 11 gauge sheets bent in the U-shape with the edges turned over, thereby affording a means of riveting it to the ordinary sheeting, and dispensing with the angle-irons. For the inner lift the stiffener is of course placed on the inside, and for the outer lift on the outside, at distances of about 14 feet. In the case of the middle lift the same principle applies, but with slight modification, because the space is limited. (See illustration.) The outside stiffeners, to prevent rusting internally, are in communication with the interior of the holder.

The *cup* being the part that can be least protected between wind and water, and when worn out very difficult to repair, should be made of sufficient substance to last out the holder—say 50 years. I have met with nothing that appears to me so good as the bent cup formed of a single thick plate, which was the unpatented invention of the late George Piggott, and was first introduced in a gasholder erected at the Old Kent Road in 1862.

Guide Carriages and Rollers.

There are three systems—viz., the English or radial, the French or tangential, and a combination of the two. The first is the simplest and the cheapest, and fully answers the purpose for all ordinary structures. By this system the wind pressure on the holder is borne by about one fourth of the total number of guides, whereas by the French or tangential system one-half of them come into play ; and by combining the two the gasholder obtains a bearing on about three-fourths of the guides. Where gasholders of extraordinary size are in question, and a diagonally braced framing is necessary, the tangential rollers are very effective, as they transmit the stress in almost a direct line with the diagonals, instead of transversely or nearly at right angles, as is the case with radial rollers. I must, however, admit a strong preference for the combination in the case of very large holders, although I think they would probably be safe with either simple system ; but while any element of uncertainty remains, the bringing of three-fourths of the guide framing into actual contact with the stress of the wind on the gasholder is an advantage not lightly to be dispensed with. The combination possesses the further advantage that, owing to the side stays on the carriages, the stress on the curb is much better distributed than is the case when radial rollers only are used.

The guide framing offers the greatest field for the exercise of engineering skill. It is not at all certain that anything like the full force which the wind exerts on the side of the holder is transmitted to, and has to be resisted by, the guide framing. High winds always exert their greatest force in sudden gusts, in which, from observations made during the notable gale of Oct. 14, 1881, I am satisfied that so soon as the maximum of any gust is reached—rising probably by jerks—the pressure is not sustained, but at once begins to recede. In that gale there is proof that a pressure of 25 or 26 lbs. on the square foot was sufficient to cause all the destruction that took place in the neighborhood of London. It is therefore quite safe to take 40 lbs. on the foot as the maximum wind force. The wind acting on a cylinder exerts, according to the highest statement I have met with, only 57 per cent. of the force with which it would bear upon a flat surface a reduction to this extent must therefore be made in the calculation. But I should not make any allowance for the protection afforded to the lower portion of a gasholder by the contiguous buildings.

Opposed to the force of the wind there is, in the first place, the *vis inertiæ*

of the holder itself when it properly fits the framing; and as this can only be overcome by sustained pressure, it alone is sufficient to neutralize the fiercest gusts of wind. Added to this there is the weight of the framing, which, with proper workmanship, should fit the holder, and thus nearly double the dead weight to be set in motion before any mischief can result, if the guide wheels and carriages are of sufficient strength. If, on the other hand, the holder does not fit the framing, and oscillation of the former can take place, wheels may break or get off the guides, and, in fact, anything may happen with even a moderate wind. It is, then, essential that the most extreme practicable accuracy of fit between the holder and the framing should be attained.

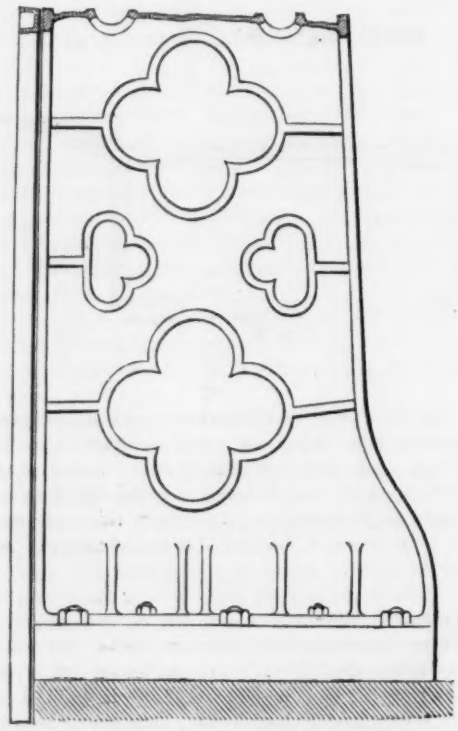
For small holders of 40 or 50 feet diameter, the late John Kirkham used isolated cast iron tripods tapering from a very broad base to a point; and for larger holders he connected the tripods by means of cast iron girders. The style of framing that has found most favor is the series of cylindrical columns connected at the top only with cast iron or wrought iron girders. For heights of 50 or 60 feet this is all that is necessary, and even up to 80 feet, by adding an intermediate girder, the system answers perfectly without diagonal bracing. The question whether this or some other plan of framing should be adopted is mainly one of economy, excepting in very exposed places, where a diagonally braced framing is necessary; in which case the cylindrical column seems to be out of place.

Provided the girders are thoroughly and strongly secured to each other, and to the columns (which is not always the case), the system of columns is better than at first sight appears. With radial rollers only, the stress caused by the wind upon the holder is transmitted to about one-fourth of the columns; but these being connected by the girders to the whole series, while the holder acts as a strut to keep the circle true, it follows that the force exerted on the holder must be sufficient not merely to break the few columns which receive the pressure, but the whole series, short off at the base, always supposing the holder to be accurately fitted to the framing. To resist such a strain the round column is better than any other form of standard that can be adopted, because it is of equal strength whether forced over backward, or sideways. With this system of columns and girders only there is nothing but a number of cast iron posts, depending entirely for their power to resist a force applied at the top on the strength of the metal at the base of each column, which multiplied by the total number of columns gives the total resisting force; and for all moderate heights it has been found in practice to be quite sufficient. It is obvious that the resisting power can be enormously increased by the application of diagonal ties or bracing, as is shown most strikingly in the case of the mast of a ship; thus rendering possible a reduction in the weight and strength of the individual columns, which might be much greater were it not for the fact that where radial rollers are used the diagonals give the minimum of support to those columns which receive the whole of the stress from the gasholder. Hence the adoption of the upright girder form of standard, which is strong from front to back, to resist the pressure of the guide rollers, while the diagonals give all the needful strength sideways or laterally. The diagonal bracing has the effect of converting the series of isolated uprights into a cylinder whose base is equal to the diameter of the tank, usually with a height less than the diameter; and providing the various members composing this cylinder—the uprights, the girders or struts, and the diagonals—are properly proportioned and secured, and of sufficient strength, it must stand as firm as a rock. You have, in fact, one column, say 160 feet in diameter, in the place of 16 separate columns each of about 3 ft. 6 in. diameter.

For great heights columns become both unwieldly and costly, and necessitate large and expensive piers in the tank; and seeing that diagonal bracing removes the necessity for great lateral strength, the girder form of standard naturally presents itself. Up to 100 or perhaps 120 feet in height, it would with me be simply a question of economy whether to use cast iron standards, such as those shown herewith (this page), or the system of framing adopted for the large holder, of which a model to the scale of ½ inch to a foot is on the table.

The great advantage of cast iron is its non-liability to rust. I have known cast iron columns remain for 20 years without showing signs of rust, after being well tarred; though I could not say so much for paint. On the other hand, the tendency to rust is a very great drawback to the use of wrought iron; and this leads me to give the preference to cast iron standards for moderate heights, and to object to lattice girders because they cannot be properly protected from rusting.

With heights of more than 120 feet I consider a wrought iron diagonally braced framing is a necessity; and as it is out of the question to make the standards of sufficient depth from back to front to give them any inherent stability or power to resist the forces brought against them, I have met the difficulty by a great development of the principle of diagonal bracing, as shown in the model. The standards in this case have no stability in themselves, being mere ribs; they are supported at vertical distances of only 15 feet by the struts and diagonals, while the top is kept true to the circle by two series of trusses, each formed with a single steel wire rope. The use of steel wire is, I think, a mistake, as it is more liable to rust than iron wire, and the latter, for the same strength, would be of larger section, which would be rather an advantage than otherwise. I attach great importance to this question of rusting, and have therefore—although the framing may be said to be lattice work—entirely eschewed ordinary lattice work in the uprights and girders or struts, and all attempts at ornamentation have likewise been discarded. The great objects aimed at have been strength, durability, efficiency, and cheapness. The great size has assisted in the attainment of the last-named object; and although holders of much smaller capacity cannot be expected to attain so low a figure at less than £9 per 1,000 feet capacity, the experience gained in the construction of this holder has shown that considerable economies may be effected in the construction of holders of all sizes.



It has not been the intention in this paper to give a description of any gasholder. The large one above referred to was described and illustrated in the *Journal of Gas Lighting* six months ago, and with that description the principles set forth in this paper may be studied. Whether those principles are right or wrong time must prove; they are simply set forth as the result of my experience, aided to a very great extent by the opinions, the practice, and the ever-welcome criticism of the many able men with whom it has been my good fortune to be associated, either in the design or construction of gasholders, or in friendly discussion of the subject.

There is room for great improvements in the future. Gasholders of very large size will be common, and on them it will be the pride and pleasure of engineers to bestow their utmost energies. By the aid of the combined system of rollers it may be found that gasholders will work well and safely with a guide framing considerably short of the height to which the holder rises. To march forward, it is imperative that the freest criticism should be bestowed on all work done and all theories advanced. I am conscious of many deficiencies in this paper, and it would be absurd to suppose that it is free from errors and mistakes. It is therefore to be hoped that the deficiencies may be supplied and the mistakes corrected by the critical discussion which is now invited.

DISCUSSION.

Mr. C. Hunt (Birmingham) said it was quite unnecessary to observe that this highly important subject had been dealt with in an eminently practical manner, and that the various details had been described by Mr. Livesey in a way that was perfectly intelligible to everyone present. Mr. Livesey had begun by remarking on the proportion that the cost of gasholders bore to the total cost of gas works, which he put at one to two; but he (Mr. Hunt) thought this was rather an undue proportion for the manufacturing plant to bear. He found that the cost of gasholders was equal to the cost of the manufacturing plant; or, rather, that the manufacturing plant might be brought down to the cost of the holders. Mr. Livesey had dwelt on the disadvantages of small holders; and he (Mr. Hunt) might say that until the last few years he had had to work with no less than ten gasholders, having an aggragate capacity of 3½ million feet, and this he found to be an enormous

disadvantage. It might be said now that he was going rather to the other extreme in building two holders of the size mentioned by Mr. Livesey. He should like to acknowledge the very kind expressions Mr. Livesey had used with regard to the responsible work which he had undertaken, and also to thank him for the opportunities he had afforded him of examining in every possible way the large structure which really formed the basis of the paper under discussion. At one time he had considerable doubts with regard to the stability of it; but these doubts had been largely set at rest by an examination of the holder and of the drawings themselves. In addition to this he had constructed, for his own information, models of the framing as designed, and had been surprised at the very great stability which this form of construction possessed. At the same time he must confess that for smaller holders he was not so much in favor of the system as Mr. Livesey appeared to be, and had been a little surprised to notice in the paper some observations with regard to the columnar principle of gasholder construction which very much coincided with his own. Certanly for a moderate sized structure he should prefer the old columnar system. Among other points there was to be considered the cost of the metal, and, weight for weight, a cast iron column was very much cheaper than a cast iron stanchion of the kind illustrated. But there could be very little doubt that for large holders the principle described by Mr. Livesey and so successfully put into practice was the one to adopt. Anyone who had gone into the cost of these large structures must be impressed by the very great economy which could be obtained by ties and vertical stiffeners against the columns. Mr. Livesey had shown the way in which they might proceed in the path which it was inevitable they would have to follow, inasmuch as the consumption of gas was so greatly increasing that larger plant was wanted, and more modern ideas must prevail in the construction of gas works. But it was not to be supposed that there were no weak points in the system; and he was sure Mr. Livesey would be very glad that they should be brought out and fully discussed. He would refer to the flat ties themselves. There was no possibility of adjusting them; and, again, although the bars might be much cheaper than the other kind, yet they presented a much greater surface to oxidation than the circular form. It also appeared to him that the advantage of the tangential system of rollers was a very moot point indeed. Probably it would be found an advantage to have a bearing on both sides; but, in practice, did the rollers come into play? Theoretically, if pressure was exerted against a cylinder it tended to extend the cylinder radially in all directions; and if this took place with gasholders, then the radial system should be preferred. Perhaps Mr. Livesey would tell the meeting, as the result of his observation, how far he had found the tangential rollers come into play in the way in which they should if any benefit was to be derived from them.

Mr. G. Anderson (London) said that he did not think this valuable paper ought to have so little observation as it had yet received, though he found it rather difficult to say anything of that kind. He was very glad to think that the time had arrived when their ablest men were advocating untrussed gasholders. It was a long time since he designed an untrussed holder, which stood virtually to the present day, while many trussed holders had come to grief in the meantime. At that time an untrussed holder was a novelty, but they were now becoming very common. A few years, however, before the gasholders at the Great Central Company's works were built, there was an untrussed gasholder erected, he believed, by Mr. George Palmer, of the Western Gas Company. At that time it was considered a large holder, about 120 feet diameter, and it was untrussed. Unfortunately it came to grief in the very first year of its existence; the reason being that while taking away the trusses Mr. Palmer did not provide for any extra power at the outer curb of the holder, but made it of common 6-inch angle-iron, and therefore there was neither sufficient bridge nor sufficient strength. The holder went out of shape, and as soon as this happened, of course, down it went. Having a knowledge of this fact, when he (Mr. Anderson) had to design the holders for the Great Central Company, he simply provided sufficient strength in the outer curb to resist the greatest pressure it was likely to have to bear; and he was glad that Mr. Livesey, after all his investigations, had found out that something very similar was, in his estimation, the best. Mr. Livesey had said that a small gasholder might have trussing, but large ones should not; and he could not agree with him in this particular. He did not see why a gasholder should be trussed merely because it was small.

Mr. Livesey said it was in consequence of the weight.

Mr. Anderson said that to him this was no excuse at all. He would rather put the weight into the perishable part. The crown might be made double the thickness, and the weight put in the lower sheets, these being made three times the thickness; or he would rather put the weight in the angle-iron on the first sheet at the top, which was sometimes in the water and sometimes out, and was therefore one of the perishable parts of a holder. By so doing weight enough would be obtained without any trussing in the crown or anywhere else. He did not suppose Mr. Livesey would ever use the horizontal box girder, No. 5 on the diagram, with the sheets rising from the inner side of it.

Mr. Livesey remarked that he thought he had seen it.

Mr. Anderson said it would be a very ugly thing, and was not so good a form. The sheets should come to the outside, in order to throw the water off and make the thing more agreeable to look at. With regard to the rollers he was not quite in accord with Mr. Livesey, though perhaps if they were both to have a chat over it they might come to an agreement. He had always understood that the rollers they had been in the habit of using were both tangential rollers and rollers which pressed in front, because they had always had a good broad roller, 3 or 4 inches wide on an average, on one side of which there was a good broad rim or flange. These were adjusted in working so that it was impossible for any shakiness to take place, unless the holder were very badly fitted; therefore it appeared to him that the roller flange would have the tangential effect, whilst the roller itself would have the direct effect. He was not saying anything against Mr. Livesey's mode of proceeding, only that the tangential force could be produced without having rollers on the sides of the standards. As to the plan generally, it would certainly be a good thing if Mr. Livesey should be of opinion that cast iron framing throughout was better than wrought iron, simply on account of the painting. It must be a difficult thing to paint at a height of 120 feet, and the holder must be exposed to a great deal of inclemency, and require painting very frequently. He certainly never found any fault with cast iron. It seldom required painting; it was very durable; and by a diagonal bracing he thought it could be obtained cheaper in the form shown than in any other—certainly much cheaper than in the form of a column. Some time ago—about a year after the Great Central Company started—the engineer of one of the London gas companies was building a gasholder just the same size as theirs. He had column standards with a base-piece about 3 feet high, and then the column started from this; and he told him that the weight of this cast iron base, with a bit of ornamentation, was as nearly as possible the same as one of the 53-feet high standards at Bow. This was a good argument against these columns being as cheap as an open standard, although Mr. Kirkham, who was the first to introduce the open standard, thought they were not so cheap, because he adopted a triangular form. They adopted a single-sheet plate, and then diagonal braces and horizontal ties. By this means he always obtained a very firm framing. He remembered the first high winds they had after starting at the Great Central works in October and November, 1850. There was quite a hurricane coming up, and as their gasholders had never been tried, and there were a good many clever people watching them at the time, trying to pick as many holes as they could, he went up a ladder during the gale to see if anything was critical; but he came down very glad to know that there was not the slightest sign of movement. After that he felt confident they were quite safe, and he believed that these gasholders had been working up to the present time, and had never had an accident. He would conclude by thanking Mr. Livesey for his ample description of this very large holder, although he agreed with him that it was not "a thing of beauty." Still, this was not the object of the work; and he thought it displayed great courage on Mr. Livesey's part to erect it, because it must have been very much against his æsthetic notions. He hoped Mr. Livesey would not require to come to them next year, as he had done on some former occasions, and tell them of little difficulties turning up. He did not think he would; and he was sure they were all much obliged to him for the very open-handed way in which he always came before them and endeavored to advance the interests they all had at heart.

Mr. G. S. Page (New York) said it might be interesting to the members to hear from across the water some particulars of the most recent accident which had occurred to a gasholder, although some account of it had appeared in the columns of the *Journal of Gas Lighting*. The accident occurred very near his own home. He saw the holder standing when he went out one afternoon, and the next morning he saw it flat. He ascertained the cause of the accident, and the why and the wherefore might be interesting to the meeting. The holder had a capacity of about 250,000 cubic feet, and belonged to the Citizens' Gas Light Company of New Jersey. The columns were of cast iron, and the first cause of the accident might be laid at the door of an exceedingly severe gale, when, as Mr. Livesey had explained, the force of the wind was something like a blow, which sent the holder down. The wind had been blowing steadily for two hours. Snow had been falling in a damp atmosphere, and a great deal had gathered on the top of the gasholder. Mr. Smalley, the engineer of the Company, stood watching the holder from seven till a little after nine o'clock, and when it fell, although there was an evident leaning of the columns (one of them having broken partly from its base, and the bolts given way), it was after a gust of wind which was said to be blowing at the rate of 55 miles an hour as reported in New York. The holder then fell, every column being broken, and it fell almost over the top of the tank. The columns all fell outwardly with the exception of one, which fell inwardly, leaving nothing that was shapely. He had an opportunity of learning why the holder fell. It ought not to have fallen, but the reason was evident. It had been constructed for 4s. for stock

and about 2s. for work; the 2s. representing about 100 per cent. profit. Therefore, when the engineer of the works showed him iron bolts taken from the fallen columns, numbers of them never having entered the iron plates holding the columns, while others had only entered ½ inch, though they were intended to enter 2 inches, and when he pointed out here and there in the columns flaws which had unquestionably been there for years, he (Mr. Page) saw that one of the difficulties under which they labored in the United States, but from which he believed companies were exempt in England, was that of a company coming in, taking the ground, laying its pipes, constructing its works, and the builder taking the money and stock, and leaving the works to fall. One of the most striking features he saw in London as he went southward was the magnificent structure described in the paper just read, rising far above every other building. He pointed it out with pride to some of his friends who were interested in the electric light companies, saying, "That is the loftiest monument of the gas industry, which never will come down; while your electric light shares are going down every day, and will soon go out of sight."

Mr. Foulis (Glasgow) said he understood Mr. Livesey to say that he considered if 40 lbs. per square foot of wind pressure was provided for it was sufficient for any structure; but he (Mr. Foulis) thought this was rather unsafe, because they knew that not later than last winter the wind pressure went as high as 50 lbs. per square foot. It was quite true, as Mr. Livesey said, that it came in gusts, but it was just those gusts which every engineer had to provide against; and though gusts did not probably strain a structure so much as a continued pressure, they ought to be provided for in every structure in this country. He believed 50 lbs. per square foot, as stated in such works as that by Professor Rankine, and in all French works on engineering, was a pressure that ought to be provided against. Not that he suggested that Mr. Livesey's holder would not stand 50 lbs. pressure; but he thought, in designing and calculating strain on such a structure, 50 lbs. per square foot ought to be allowed for. In talking about the weight to be overturned, Mr. Livesey spoke as if he thought the gasholder was so held by the guides that it became practically one piece with the framing, resting on a solid base; but he (Mr. Foulis) did not think it was possible, in a structure of this kind, to get so exact a fitting as would bring about this condition of things. They must, to a certain extent, look upon a gasholder as being a floating body, having a definite amount of stability; but it would be scarcely safe for them, in calculating the strength of the framing, to simply reckon that they had to overturn the holder as if it were a mass of 300 tons weight resting on solid ground. A great deal of the stability of the structure would depend upon the perfection with which the joints were made, and he should like to know what precautions had been taken in this respect.

Mr. R. Harris (Bow Common) said as the gasholders at the Great Central Gas Works were mentioned indirectly in the paper and directly by Mr. Anderson, it might be interesting to the members to know that he (Mr. Harris) had had charge of those holders for rather more than 20 years, and they had always worked very well. They had never given him any trouble or anxiety, but had remained perfectly firm and substantial. The only repairs they had needed had been at the connections between the diagonal and horizontal stays and cast iron columns. These connections were made with cast iron brackets; and from the effect of the wind and other causes they had been somewhat strained at times, and fractures had taken place. Some of the brackets had needed replacing, but this was the only difficulty that had been experienced in working. The gasholder at Kensal Green had been mentioned as having fallen to pieces. This was constructed without framing and had a flat crown. He happened to see that holder go to ruin, and he believed it would not have done so had the columns been able to stand and retain the top curb in its proper position; but the fact was that, from an excessive strain coming on the curb (traced to a great extent at the time to a mass of cast iron which had been suspended from the bottom of the holder to give increased pressure), and the curb not being supported sufficiently by columns round the exterior, it gave way. Some of the columns fell outwards, the crown of the holder became of an oval shape, and the whole thing collapsed together. In reconstructing the holder the late Mr. Wright adopted the form of a box girder for the top curb, and this he believed was in existence at the present time.

Mr. Corbet Woodall (London) said he was hardly surprised at the effect the model, and especially the structure it represented, had on the feelings of their American cousin. It was a very big thing, and he too, in passing it, had been impressed by its enormous size. He also regared it as a proud evidence of the liberty enjoyed by an Englishman to do exactly as he pleased, even to the extent of deforming a district. When, however, Mr. Livesey told them that they had not by any means reached the end, but that companies in all cases in future should be content, whatever their size, with two gasholders—that Mr. Trewby, for instance, with his daily make of 30 millions, should have two holders, each of 15 millions capacity—it occurred to him that a protest was necessary. Surely it could hardly be seriously argued that, where gas works were to be placed in anything like close contiguity to a town, a gasholder of the size of that in the Old Kent Road was not already too large, and a larger would, to his mind, be an insult to the neighborhood in which it was placed. He should like to ask Mr. Livesey why, seeing he was so satisfied—and he (Mr. Woodall) cordially agreed with him in his satisfaction—with the framing he had designed, it should not be equally suitable to a holder of, say, 100,000 cubic feet. There was an expression in the paper that large holders were necessarily less troublesome than small ones; but it appeared to him that it was entirely a question of design, and not of size—that the proportions being right, a small holder ought to work as well, and just as efficiently as a large one. So also with reference to the character of the framing. If it were good for a large size, he could not see why it should not also be good with regard to a small one. On the question of trussed and untrussed crowns, he had not much experience practically of trussed ones, for he never built but two or three. Very early in his professional life he concluded that it was the right thing to follow in the road of the pioneers whom Mr. Anderson had named; but when Mr. Livesey, in his paper, spoke of the system of trussing having been condemned in the year 1868, it was only right to remind the members that his late friend Mr. Innes designed a holder of 160 feet diameter without a framing some years earlier than 1868—he believed in 1854. On the question of curbs, Mr. Anderson condemned fig. 5, but he presumed only because of its position in relation to the side and top sheets. When the same form was inclined, as in fig. 6, he thought there was very little to be said in condemnation of it. Naturally he said so, because this was practically the form he adopted in the last large holder he had built. What they had to secure in the top curb of a holder under considerable strain, because of the low angle of the roof, was that the curb should be a girder placed in the possition most suitable to support the strain upon it. If the girder had but one table and a web plate, as in the case where the curb was formed of one angle bar and a thick plate, then the iron was badly placed; but by putting in the second angle-iron, which was the plan adopted by him in two or three of the holders at Kennington, they put in the lower member of the girders and added greatly to its strength. The top sheet was made to be the web, and the outer and inner angle-irons the two tables of the girder. Having to build a very large holder, he found that this form did not give the requisite section to restrain the pressure which would come upon the curb, and therefore, instead of the two angle-irons he adopted two channel-irons 10 inches in depth and covered by plates top and bottom, making a box girder 11 inches deep inside, and about 3. ft. 6 in. in depth from front to back. This gave an excellently strong girder for the purpose it had to serve.

Mr. R. Morton (Nine Elms) said that he simply wished to express a little of the disappointment which he felt that Mr. Livesey, having succeeded in so minimizing the material used in the framing of his last gasholder—one might almost say so etherealized it—had not given the members something more of the idea he hinted at in the *Journal of Gas Lighting* some few months ago, for doing away with the top framing altogether. He (Mr. Morton) had very considerable doubts about the framing of the holder described in the paper; but he must say, having seen it both at a distance and close at hand since it was finished, his ideas had been considerably modified. He should nevertheless still prefer to let the holder stand a year or two before giving its design unconditional approval.

Mr. Woodall asked whether the question of the freezing of the lutes of the lifts, especially the upper one, had been considered, and how Mr. Livesey proposed to deal with it.

Mr. W. Cleland (Liverpool) said he did not know whether it would be considered rather presumptuous for one who had never had to design a gasholder to make any remarks on this occasion; but he took courage to do so by reflecting that there must be many in the same position as himself, and perhaps they would like to have a few remarks on what he had observed in superintending the construction of gasholders and taking charge of their working. One of the great advantages of having plenty of gasholder room was that it enabled the managers to meet the irregularities of demand in a much less expensive manner than by throwing retorts out of use and putting them into work again. There was one point Mr. Livesey had not touched upon, but perhaps he would do so before concluding—namely, that as the strength of a chain was only the strength of its weakest link, the proportion of strength in the different parts of gasholders was of much importance. His attention was drawn to this some years ago in consequence of what he saw in the papers respecting the destruction of a gasholder at Beckton. He looked into the matter in a holder which had recently been constructed, and found that the strength of the girders and columns was not utilized to more than 40 to 50 per cent., in consequence of the defective strength and number of the bolts and rivets. At that time—a good many years ago—those details were left to a considerable extent to the contractor; but now they were more attended to than they were. If the strength of the framing were calculated simply by the strength of the angle-irons and plates and castings composing it, it would be supposed to stand a certain pressure; but, of course, this would be altogether delusive if the fastenings were weak. They were told

that a gasholder was intended to act as a regulator in the storage of gas; but there was one point that required very careful looking into, and that was the tightness of the whole. No holder had yet come under his observation which was perfectly tight; and it struck him that if the percentage of loss by leakage were carefully traced, a large proportion of it would be found atributable to the holders. How to overcome this was a question. He doubted if a new holder, constructed as at present with the greatest care, would be found to be tight; it would be found to be losing gas, though the temperature remained the same. How much of this loss was due to absorption by the water, and how much to leakage, he could not tell; and he should be very glad if Mr. Livesey could give the meeting any information as to securing tightness. The advantage of cast iron columns with regard to resisting rust was an important point. To prevent columns rusting internally he found it very useful to allow a thorough ventilation by a current of air through them, while excluding rain; because with closed columns the moisture kept shifting round from side to side according to the heat of the sun, so that the different parts were alternately wet and dry, thus causing the column to rust rapidly. With regard to the pressure of the wind, perhaps he did not comprehend Mr. Livesey perfectly, but he understood him to reckon 40 lbs. per square foot. If he meant this as the effective pressure on a vertical section of the holder it might be correct, but if it meant the real strength of the wind he must say that in Liverpool they experienced gales which rose to 75 lbs. to the foot. With regard to the importance of the pulleys touching the guides, there could not be any doubt that it was a great practical difficulty to secure any given number of pulleys touching the guides from top to bottom, and to ensure it much more pains than he had yet seen bestowed in the construction of the framing would be necessary. As far as he could see, the perpendicularity of the columns seemed to depend on the perfect exactitude with which their parts were turned in the lathe. The base was leveled with as much care as possible, and it was supposed that when a column 50, 60, or 100 feet high had been erected, the center of that column would be perfectly plumb. But this was a great assumption, and he questioned if it was ever fulfilled. Then, in fixing the guides to the columns, dependence was chiefly placed on the brackets being perfectly planed, and on the straightness of the casting of which those guides consisted; but it was impossible to cast guides so straight as to make the pulleys touch in all parts.

Mr. C. E. Jones (Chesterfield) said that having two forms of construction —untrussed and trussed holders—under his care, and having had some experience with them, he had arrived at the conclusion that there was no just cause for trussing gasholders. It appeared to him, from the remarks he had heard, that an idea existed that untrussed gasholders were a new idea; but he had some on his present works which had probably existed more than 40 years. There were two of them, one being constructed by an engineer in the room. It was a thing of "airy lightness," and he admitted that it had cost him great anxiety in windy weather; but for all this he thought the principal of trussing gasholders was open to very grave doubts. He had other holders which were heavily trussed, but he thought there was as much stability in untrussed gasholders, if properly constructed, as in trussed ones. He preferred columns to brackets as standards to gasholders. It appeared to him the correct mathematical form to adopt was that of a column, because an equallzation of force in windy weather was obtained with columns, which one could not hope to obtain by the use of brackets. He could not go into the details of the paper so much as it deserved, but it occurred to him that in the framing there was an objectionable feature in the multiplicity of joints. He also thought that with wrought iron there was great liability to oxidation. They all knew that in tubular bridges and other structures tons and tons of rust were taken out from time to time. He should like to ask Mr. Livesey if he would tell the meeting whether he had made any calculation with regard to the gradual waste of iron on the framing per annum from this cause, and what the life of the framing would be as compared with cast iron. His own impression was that, with the multiplicity of joints and liability to oxidation, its life would be far shorter than that of cast iron framing.

Mr. C. R. Mead (Sutton) wished to ask Mr. Livesey why he preferred a wire rope to the ordinary tension rod round the top. He (Mr. Mead) some time ago designed a holder for Hong Kong, where excessive gales had to be encountered. Its girders were strutted by struts from the center, and tension rods from end to end. The struts were made with a lock nut and tightening nut, so that they could be tightened up to the required degree of tension. He would also ask Mr. Livesey why, instead of making the diagonal tension rods simply rods of fixed length, he did not introduce gibs and cotters at the end for tightening, or wrought iron rings in the center and tightening nuts in the ring. It appeared that the rods were of a fixed length, incapable of adjustment; and he should like to know why these alterations from the ordinary practice were made.

Mr. S. Hunter (Salford) said the discussion had turned in some measure on the question of wrought iron versus cast iron framing. He should like to put it to Mr. Livesey whether, if cast iron were used, is would not be absolutely necessary either to make the structure immensely strong, and to use a large quantity of metal, or if it were made so light as to bring it within reasonable cost, it would not be dangerous in working. If he might anticipate his reply in this respect, he thought that this would be the answer, and that whatever the wear and tear might be with wrought iron, cast iron would, on account of cost, be absolutely impracticable if made strong enough, or else dangerous in working if of light construction.

Mr. Livesey, in reply, said he was much pleased with the discussion, and not the least with the criticisms which had been passed upon the paper. He was not altogether in favor of the braced system for small holders, because the ordinary plan was easier to construct. It was a question of economy and convenience of construction for small holders, for which the ordinary column and girder would answer every purpose. Two gentlemen—Mr. Hunt and Mead—had spoken about the adjustment of the ties. The governing principle had been to get the greatest strength with the least expenditure of material and money. If he had used round ties and adjusting screws, with a ring in the center, in every bay, there would have been something like 80 struts or welds. The strut might be the strongest part of a bar of iron, but it might very easily be the weakest; therefore struts had been entirely avoided, and these diagonals consisted of one flat bar the whole length, with no joint whatever, riveted to each upright with a proper number of rivets, in such a manner as to weaken the diagonals as little as possible. The idea was to maintain the full strength of material as far as possible right through; and when once properly fitted and fixed no further adjustment was necessary. Mr. Hunt asked whether the tangential rollers came into play. He had been on the holder a good many times since it had been at work, and he found nearly all the rollers came into play to a much greater extent than he had expected—the radial rollers at all points, and a very large proportion of the tangential rollers. The question of oxidation had been raised by one or two speakers. He had not allowed for oxidation, because they did not intend to allow any rusting to take place. There were no joints or crevices, as in lattice girders, that could not be easily got at to paint. Every part was accessible to the paint brush, and it was their intention, in the first instance, to give it two or three coats of red lead in succession, and thus to fill up every interstice where water could lodge, and so absolutely protect it from rust. The light hand-rail round the top of the holder, instead of ornaments, was very useful, enabling the men engaged in painting to suspend their tackle from any point. As to trussed crowns for small holders, he had only recommended them where additional weight was wanted, but he thought Mr. Anderson had the best of the argument. Flanged rollers he did not like so well as tangential rollers. They did not work very smoothly, but when they came into play would grind against the side of the guide. There was a question between Mr. Anderson and Mr. Hunt about the column and the standard, and he agreed with the latter that the standard was rather difficult to cast, owing to the unequal contraction of the web and the back and front flanges. Whether a standard or a column was to be used was mainly a question of cost. The tank was constructed on the same principle as the one that some few years ago developed a few cracks, which they succeeded in stopping. This tank was filled last November, and had no water put into it since, and was still full. It was a concrete tank, rendered; the whole pressure consequently being on the inner face of the wall. They put in the wall, edgewise, about 25 wrought iron bands, 3½ inches by ½ inch, which had made it secure. He might inform Mr. Page that bad work was not altogether unknown in England, and when a disaster happened to a gasholder it was almost invariably to be traced to bad workmanship and inaccurate fitting. As to the strength of the wind, referred to by Mr. Foulis and Mr. Cleland, he had calculated for a wind pressure of 42 lbs. He had no faith whatever in the registering wind gauges at present used. Mr. Benjamin Baker (a great authority on wind pressures, and the designer of the new Forth Bridge), who was employed in the investigation in reference to the disaster to the Tay Bridge, had made a report on this guide framing, which was published in the *Journal of Gas Lighting*, and in it he said that a 40 lbs. wind was the outside pressure to be allowed for. This 40 lbs. wind pressure, even if it ever occurred, could only apply to the upper part of the holder, and not to the bottom, which would to a certain extent be protected by surrounding buildings. Mr. Foulis also spoke about the accuracy of the fittings. They had succeeded in fitting this holder so accurately that at all points of the framing there appeared to be equal tension, and the holder at all heights fitted the framing; so that they could not detect any oscillation whatever from the action of the wind or any other cause. This was due very largely to the excellent workmanship put into it by the contractors and their foreman. As Mr. Foulis said, the security depended upon the perfection of the joints; and great care was bestowed upon them. The standards were put in in five lengths, and each length was allowed to lean back slightly when the struts were put in; then the rivet holes in the diagonals were marked, and drilled a trifle short. They found by experience how much was necessary, and by drifting up the diagonals, and so tightening them, the uprights were pulled

in perfectly true. He had stated in the paper that the limit of size had probably been nearly reached. He quite agreed with Mr. Woodall's remark. What he meant was that in reference to starting new works of moderate size, not more than two holders were necessary. The only thing he had to say about the box girder was that it was an exceedingly good form, but it was more expensive than mere angle iron. If angle iron would answer the purpose, a simple work of that kind was better and cheaper. He had not considered the question of the freezing of the lutes, which was one of those things that must be dealt with when the time came. They had always overcome the difficulty hitherto; and there was this advantage, that the larger the tank the greater the body of water, and the longer it was in cooling down to freezing point, so that he did not think very large holders were so apt to freeze as smaller ones. A low wall built around the bottom of the holder protected it from the action of the wind, and prevented freezing in the tank; then by uncupping it at night, and cupping it in the morning, the danger of freezing would be reduced to a minimum. In reply to Mr. Morton, he certainly had an idea that a gasholder might be constructed which would rise with perfect safety considerably above the framing; but until such a thing had been tried he thought it better not to bring it before the Institute in a paper. Mr. Cleland's reference to leakage from holders would enable him to make a useful suggestion. Some years ago Mr. Douglas brought before the Association a plan for covering gasholders with a wash of Portland cement put on over the tar. They had been trying this and tarring the holder and then washing it over with Portland cement before the tar was dry. They found that this discovered the leaks in a most wonderful manner. The mixture of the tar and cement attained a certain setting property which he believed would enable them, by applying a second coating of cement, to stop these small leaks. If the cement, too, kept its present color, it would be more æsthetic in its appearance than the black tar which Mr. Anderson seemed to think a desideratum. The wire rope round the top was employed for the sake of cheapness. In the old plan a tension-rod connecting alternate columns was used, with a stretching-screw in the middle; and it occurred to him that they might manage it by having one stretching-screw in the whole circumference, and this had been found to answer. He thought what Mr. Hunt had said about cast iron being too heavy for these great heights was quite correct. He himself should be rather afraid of cast iron for such a height.

On a New Method of Mining Coal.

By Mr. Paget Mosley.

[A paper read at the Meeting of the Iron and Steel Institute, England.]

It is proposed in this paper to give a short description of a new method of coal getting, as carried on by a process patented by Messrs. Smith & Moore, which has for several months been in daily operation at the Shipley collieries in Derbyshire.

Nearly two years ago experiments were commenced by some of the officials at these collieries with a view to practically utilizing the power of lime, which, when concentrated and used in a confined condition, produces most successful results, while the process has for its recommendation perfect safety, simplicity, and economy. The present mode of operating is to employ lime in a specially-caustic state made from limestone. This is ground to a fine powder, and consolidated by a pressure of about 40 tons into the form of cartridges 2½ inches in diameter, having a groove along the side. These are then packed into air-tight boxes to protect them from damp, and are ready to be conveyed to the mine for use. The cartridges are made by hydraulic power in a press specially constructed for the purpose, which can be erected at a small cost at any colliery. The shot-holes are first drilled by means of a light boring machine, and an iron tube, about one-half inch in diameter, having a small external channel or groove on the upper side, and provided also with perforations, is then inserted along the whole length of the bore-hole. This tube is enclosed in a bag of calico, covering the perforations and one end, and has a tap fitted on to the other end. The cartridges are then inserted and lightly rammed, so as to ensure their filling the bore-hole. After the cartridges have been enclosed by tamping, in the same way as with gunpowder, a small force-pump is connected with the tap at the end of the tube by means of a short flexible pipe, and a quantity of water, equal in bulk to the quantity of lime used, is forced in. The water being driven to the far end of the shot-hole through the tube, escapes along the groove and through the perforations and the calico, flowing towards the tamping into the lime, saturating the whole of the charge, and driving out the air before it. The tap is then closed, so as to prevent the escape of steam generated by the action of the water on the lime, and the flexible pipe attached to the pump is disconnected. Experience has shown that after introducing the water there is always an interval before the steam attains a high pressure, so that all danger can be avoided. The action of the steam first takes place, cracking the coal away from the roof, and this is followed by the expansive force of the lime. The pressure of steam generated by the usual charge of seven cartridges, as employed at Shipley, is 2,850 lbs. The expansive force of the lime can be judged by comparing the bulk of lime produced by the slaking of one cartridge with a similar cartridge in its compressed form, specimens of which are shown.

In order to further demonstrate the power contained in these cartridges, I have here two pipes which have been burst by lime cartridges used in the same way as in a shot-hole in the coal. The one broken into small pieces was burst at a lecture given by Prof. Abel at the Royal Institution on April 28 last. The piece not broken shows that the force is not exercised in blowing out the tamping if not properly rammed. This pipe was previously tested by water pressure to a strain of 953 lbs. per square inch without bursting, that being the limit of the testing power employed. The thicker pipe was burst at Shipley's collieries, it being thought unsafe to try an experiment with a pipe of such strength in a lecture room. The time occupied in drilling a hole three feet deep and 2¾ inches in diameter, including setting up the drill, averages 12 minutes; charging a hole with cartridges and tamping up, four minutes; and pumping in the water, one minute; thus effecting a considerable saving of time as compared with drilling, charging, and tamping a hole for gunpowder.

The sprags are left in under the coal, so as to allow the force to exert itself as far back as possible, and in many instances the coal is forced off and falls for a distance of several inches behind the end of the drilled holes. In 10 to 15 minutes, on the removal of the sprags, the coal falls clean from the roof, in large masses ready for loading, practically making no small. If all the sprags are removed at once, the entire length of coal operated on falls; but the collier can, if more convenient, remove two or three sprags at a time, and let down as much as he requires for loading, leaving the rest to remain spragged up till wanted. In places with bad roofs this is especially advantageous. In addition to the time saved by this process and the increased quantity of large coal that can be got in fewer hours' work, it is hardly possible to describe to those who have not witnessed it the saving of the laborious exertion to the collier himself compared with what he has to go through in wedging. Again, when powder shots are fired by specially-appointed men, delay necessarily occurs in fetching them to the spot, and, for their own convenience, they will often arrange to fire a number of shots as near as possible to one another, thus shaking the roof in that particular district of the mine.

The use of our system, however, avoids the necessity of additional propping from that cause, and further prevents any disturbance of bodies of gas from concussion by the firing of powder shots. It also renders it unnecessary to employ a separate set of men for firing shots while the men are out of the pit. The following are among the principal advantages claimed for this system:

Absolute immunity from explosion of gas, there being no fire or flame. There is no smoke or noxious smell of any kind. The roof is not shaken by this process; no vacuum is created, as is the case with a blown-out shot; and the coals in falling produce much less dust. It has been proved by recent experiments that coal dust finely divided and mixed with atmospheric air is sufficient, even when no gas is present, to carry the flame of a blown-out shot to a considerable distance; and also that dust, air, and gas together will carry flame more than twice the distance that it will when there is no dust; moreover the presence of dust considerably aggravates the effects of burns. Skilled labor is unnecessary, and the coal can be got with much less exertion to the collier than by wedging. The apparatus is simple and inexpensive; it is easily carried about and kept in order; and it can be used in narrow and cramped workings, and in thin seams. After pumping the water into the charged holes, the men need not discontinue working, as is the case with gunpowder; for by simply moving away from the face of the coal while the sprags are being taken out, all risk of injury from falls is avoided. Any number of holes can be loaded, and by applying the water to them in quick succession, a continuous and gradual pressure is brought to bear along the face, which causes the coal to fall in large masses. It is thus brought to bank in a better condition for stacking or carriage than by any other means; and the results, when compared with wedging or powder, show a considerable increase in the percentage of large coal got.

The following statement of the comparative working of two stalls adjoining one another is given as a fair average specimen of the economy of labor and the increased output of large coal resulting from the use of this process throughout the Shipley Collieries.

[*For Table of Comparative Workings, see next page.*]

Thus far, I have alluded principally to the commercial value of this method of coal getting, and the profit to all concerned resulting therefrom; but far more important than this is the absolute safety it provides from all risks of explosion, as well as the protection it affords from the numerous accidents constantly occurring through falls from which the men cannot get away in time, while standing in front of the face to hammer down the coal; a class of accidents very frequently and strongly alluded to in the evidence laid before the Commission on Accidents in Mines, now sitting, as a reason why different

Comparative Results of the Lime Patent and Wedging at Shipley Collieries.

1882.	Wedging. No. 2 Stall, Woodside Pits.		Lime Patent. No. 1. Stall, Woodside Pits.	
	Hours of Labor.	Tons got.	Hours of Labor.	Tons got.
Week ending January 25.....	96¾	225	58	274
" February 1.....	100	178	71	236
" February 8.....	123	225	90	258
	319¾	628	219	768

140 tons more coal were thus got with 100 hours' less labor by the use of the lime than by wedging.

by gunpowder, with the risk attaching thnreto, is almost preferable to wedging. The new system of coal getting, I may add, has been seen by several of the Royal Commissioners on Mining Accidents in two of the pits at the Shipley collieries, one of which has been only recently opened out so that there is little or no weight on the coal; and I have the authority of Professor Warrington Smyth, Professor Abel, and Mr. Burt, members of the Royal Commission, who have visited Shipley, to say they were much gratified to see in practical working a method so obviously favorable to the safety of life and limb, and one which accomplished its purpose so thoroughly, and with such economy in regard to the high proportion of large coal obtained by its use. To them, as to the public generally, the most important recommendation of the new process must obviously be the almost entire immunity which it provides against accidents from shot-firing and from falls—two of the most serious causes of loss to human life with which coal mining operations are now attended.

In the coal fields of Europe and America together, the number of fatalities annually occurring in coal-mining may fairly be numbered by thousands, and it is a serious reflection upon our scientific knowledge that heretofore it has furnished no adequate remedy for getting rid of, or even sensibly reducing, the risks incidental to this most precarious employment. It is lamentable to be compelled to state that so far from any such result having occurred the number of those killed in coal mining not only shows an absolute increase from year to year, but in some countries, as in Austria and Germany, has been increased relatively to the total number of hands employed. It is thus, perhaps, the chief merit of the new process I have endeavored to describe, and it is certainly the claim which, of all others, its inventors put forward with the greatest pride, that it enables the coal hewer to carry on his trade with practically the same amount of safety as pertains to other occupations, and we do not hesitate to say that the universal adoption of caustic lime for getting the coal, combined with the introduction of a more perfect safety lamp, would make mining mortality a very different thing to what it has unfortunately been in the past.

The process has been tried most satisfactorily in other collieries besides those at Shipley, and I will only add, in conclusion, that the proprietors of the system, which has been patented in Great Britain and several foreign countries will be happy to show it to any members of the Institute or to others desirous of seeing it in daily operation.

The Coal Production of France.

Strange to say the French people, with all their habits of industry, economy and thrift, appear to have been very negligent in the matter of developing the mineral wealth of their coal mines; and, according to excellent authority, are more dependent now upon their neighbors for their supplies of coal than they were thirty years ago. The following interesting facts upon this subject are taken from the London *Mining Journal:*

While England has carried her annual coal extraction to about 130,000,000 tons per annum, while Germany has now risen to nearly 50,000,000 tons annually, and while between fifty and sixty millions tons are now extracted every year from the soil of the United States, the utilization of the coal wealth possessed by France makes but slow progress. Still, French coal mining cannot be said to be a stationary industry. Some advance has undoubtedly been made during the last twenty years. In 1850 the production of coal in France stood at 4,433,567 tons. In 1860 this total had receded to 4,309,622 tons, but in 1870 it had been carried to 14,330,008 tons, and in 1880 it had further expanded to 19,412,412 tons. The imports of coal into France in 1850 amounted to 2,791,700 tons; in 1860 to 5,900,630 tons; in 1870 to 4,779,650 tons; and in 1880 to 8,635,014 tons. The French have thus become more dependent upon their neighbors for coal than they were 30 years since. The consumption of coal in France has outstripped the production during the last 30 years, although not to any very material extent. We may just note that the consumption of coal among the French stood in 1830 at 7,225,267 tons; in 1860 it had risen to 10,270,252 tons; in 1880 to 10,109,958 tons; and in 1880 to 28,047,126 tons.

The great growth of steam power, and the progress of wealth and luxury among the French no doubt account for the continual increase in the production. Although the French have not succeeded in supplying their coal requirements, they have, however, not been altogether unsuccessful in their efforts to keep pace with the progress in the demand for coal on the part of the French public; and it is certainly satisfactory that this should be the case, as in every country which claims to occupy an important position in the world ought clearly in these days of steam railways, steam shipping and steam impelled industries to, at any rate, substantially meet its own requirements if it cannot spare any black diamonds for its neighbors. Probably the principal reason why coal mining has made such comparatively slow progress among the French is the fact that until within a comparatively recent period manufacturing industry has not acquired such an important development in France as in Great Britain and the United States. Another cause which has tended to reduce the production of coal in France has been the tendency of the French to embark in agricultural an vinicultural industries in preference to a pursuit requiring them to pass a large portion of their lives underground.

The gay and lively Frenchman is, to some extent, a child of the sun, and he does not feel himself when deprived of the light and warmth of that great luminary. The third influence which tends to check the progress of French coal mining is the magnitude of the standing army maintained by the French Government, which diverts a large proportion of the flower of the French youth from useful pursuits of every kind. Nevertheless, in spite of every obstacle, and every drawback, coal mining makes some advance in France; and as manufactures grow in importance there is no doubt that the extraction will increase still further in response to the influence and pressure of a growing demand.

The same tendency of population to desert rural districts and to crowd into great towns is observed in France as in other countries; and as this tendency is highly favorable to the development of manufacturing pursuits which depend upon steam for motive power, it is calculated to assist and encourage the further progress of French coal mining.

A Fire Escape.

Mr. J. E. Codman presented the following description of a fire escape, at a meeting of the Engineers' Club of Philadelphia:

A brick tower, to be erected convenient to the external or street walls of a building; may be situated either inside or outside of said walls as opportunity may favor, and tower to be of such height as to give access to it from the roof.

Plan of tower to be cylindrical, with a central shaft of about 27 inches diameter; around said shaft is formed an inclined winding passage, 2 feet 3 inches in width, making the inner diameter of tower about 6 feet 9 inches. Floor of said passage to be curved or U-shaped, and be about 6 feet clear in height. The surface of inclined passage or channel to be perfectly smooth or glazed, and be constructed with fire-proof material.

The tower will have access to it by fire-proof doors, from each story and roof; doors to be in two folds, to be fastened on the inner or room side by bars or latches only, doors to open outward and be contained in the thickness of walls. There will be no door at foot of tower, but the passage or inclined channel will terminate in a vestibule or fire-proof chamber, 6×10 feet, in the outer walls of which will be a large doorway to street, made and secured in same manner as described for the other doors.

The incline is proposed to be at an angle of about thirty degrees, but will be interrupted by retarding curves of less gradient to control and equalize the momentum of bodies gliding down the incline in a *sitting posture;* the bottom grade will be so reduced as to bring the moving body to a rest in said vestibule.

The intention is that man, woman or child using this mode of escape, shall enter the passage or channel from any of the stories or roof and assume a sitting posture, in other words, squat down, and thence glide to the bottom of tower, in a safe, rapid, easy and continuous mannner, one behind the other; the width of channel and curved form of seat or surface, confining them to this course, independent of their inclination to do otherwise, and thus obviating crowding or packing.

The retarding or flattened curves form convenient starting places on entering the tower.

From the nature of this mode or form of escape there can be no falling or crowding by the strong over the weak, as would happen in the use of stairs of any form during a conflagration and consequent excitement.

Any one fainting on entering the escape would be safely carried to the bottom.

This escape is adapted to any height of building, number of stories or height of stories; less costly than a stair, and taking up less room than a stair built for ordinary purposes.

A Broken Circuit.

The New York *Daily Times*, of July 27th, gives the following reasons why Washington Square was dark on Tuesday evening, July 25th:

The electric lights in Washington Square and on Fifth avenue and Broadway, from Waverly place to Fourteenth street, were not lighted on Tuesday evening until 11 o'clock, and as gas is no longer used on these sections of those thoroughfares, they were shrouded in comparative darkness, which occasioned a good deal of comment from the people passing through them. This section of the city is lighted by contract by the United States Illuminating Company, of which Eugene T. Lynch is the President. Mr. Lynch explained to a reporter the failure of the company to furnish light on the circuit at the usual time, about 7:45 in the evening, by saying that the circuit was open, and the break was not discovered and closed until about 11 o'clock. "The circuit," he said, "begins at our station opposite the Academy of Music, in Fourteenth street, passes along Fourteenth street to Fifth avenue, down the avenue to Washington square, through the park to Waverly place, thence to Broadway, up which it passes to Fourteenth street. There are 27 lamps on the circuit, and it is tested six times a day. The last test on Tuesday was just before 6 o'clock, and the circuit was complete at that time. When the time came for illuminating, however, the lamps would not light, and of course the only thing to be done was to examine every lamp until the break was found. To do this required some time, and it was nearly eleven o'clock before we discovered that a wire was detached from the lamp on the south-east corner of Washington Park. The wire was not cut; it was simply disconnected, and the circuit was soon closed and the lamps were lighted. It was a moonlight night, and on no part of the line was it dark enough to cause any serious inconvenience."

"Have you any idea how the wire became disconnected?" asked the reporter.

"It looks very much as if it was done maliciously," answered Mr. Lynch; "but of course I can make no charge of that kind. It might possibly have been the result of an accident, but our men are very careful, and the accident, if it was one, must have happened after the six o'clock test. Such a thing, unless it was done designedly, would not happen once in a thousand days."

Employing Waste Products of Coke Ovens.

In view of the rapidly growing importance of the coke industry of the United States, anything which will tend to render more profitable the working of this material will be hailed with satisfaction. The above subject is now, and has for some time past, been attracting the attention of scientific men in England, and it is to be hoped that some practical benefit will result from their studies. *Engineering* contains the following relating to this topic—

'A change of some moment in the manufacture of coke seems likely to prove a great benefit to the coke manufacturers in the South Durham district. It was feared a few years ago that coking coal of that great district would be speedily exhausted, but the introduction of the disintegration process, enabled coal that had been previously deemed unfit, to be used in the manufacture. And there is now a successful attempt to utilize what have been previously bye-products in the manufacture.

"About twenty years ago attempts were made in this direction at the great works of the Messrs. Pease, at Crook, but they were given up because of the limited results. Some two years ago a paper was read at the meeting of the Iron and Steel Institute of the success of French attempts in this direction, and the method has now been successfully attempted near Crook, and it is likely to be adopted elsewhere in the Durham coal field. It is evident that success will be of the utmost value to the coke manufacturers, because the bye-products that have been wasted become valuable—so valuable that the aggregate value of the quantities that could be obtained from the coke made in this country for metallurgical purposes alone, has been estimated at one million sterling. If even a portion of this sum can be realized by the makers it will be an immense benefit, and will lesson a great evil in the coke burning district.

"The production of coke, too, in the South Durham coal field is continually growing, and in that growth there has been the enlargement of the need for some method of utilizing what have been long the waste products of manufacture. In the score of years that have elapsed since the early efforts were made, the values of tar and ammoniacal liquor have been very greatly increased, and thus the value of the success of the present attempts is much more than it would have been a score of years ago had success fully attended it then.

"It remains to be seen how far the process will be adopted, and whether there will be a field for the use of the whole of the liquor that will be produced as the use of the process enlarges the production. Its value is great, and it is to be hoped that its adoption may be expedited by the increase in the value of the products that have been so long wasted."

Petroleum Surprises and Developments.

The New York *Daily Tribune* makes the following interesting statements about the "flurries" which have taken place in the petroleum market when unexpected and large additions have been made to the oil-producing territory. The decline in the newly-discovered Warren field appears to have commenced already; but the very existence of this Warren field goes far to show that the calculations lately made by Prof. Wrigley, as to the probable limit and capacity of the oil-bearing sands of Pennsylvania, are not to be in any manner accepted as conclusive:

"The history of the discoveries in the oil fields in this country has been one of a series of disappointments to the producers. From 1866 to 1872 the price per barrel averaged from $4 to $5, and the producers were making money rapidly. Then the field in Butler County was struck, and from that day to this the production has been greater than the consumption. Before Butler had begun to decline the Clarion field was opened. Then came the Bullion pool with its 2,000 and 3,000 barrel wells, which forced the price down to $1.50. This field was soon exhausted, and better times for the producers were at hand, when the Bradford field, the largest in extent ever known, was opened. For nearly five years the Bradford field increased its production, until it had a daily output of over 100,000 barrels. The consumption was not over one-half this amount, and, with the Standard Oil monopoly squeezing the producers, many of them went to the wall. Then Bradford began to decline, and again a silver lining was seen in the cloud; but again disappointment came. In May, 1881, the first well was struck in Alleghany County, New York, and a new field was opened which soon more than made up for the decline, and again the producers looked forward to the near future when the consumption would equal the production. Then was the great '646' mystery struck, and with it followed disaster to the owners of wells generally, and lower-priced oil than since the summer of 1874, when for a short time it sold for 45 cents a barrel. Where the next field will be is only a matter for conjecture.

"The only time when the excitement over a new oil field was as great as that now reigning in the Cherry Grove district was in 1865, when the Pithole fever took possession of the public. The first well was opened there in May of that year. In less than two months Pithole was a city of considerable proportions, and within six months it had 8,000 inhabitants and almost as large a floating population. At the pinnacle of its greatness it had fifty hotels, some of them palatial and gorgeous, and one of which cost $80,000. It had miles of streets lined with banks and all kinds of business establishments. A $50,000 transaction was considered of small account, and, miscalculating the future of the place, wealth was squandered on new enterprises which in the minds of its citizens promised fabulous fortunes; but Pithole was only a child of six months' growth when it began to exhibit symptoms of an early decay, and it declined almost as rapidly as it sprang up.

"The *Tribune* correspondent visited Pithole the other day and found only one voter living in the place. The railroad was long ago torn up, and most of the houses were torn down. Two of the streets are still open, and beside them remains a pitiful scattering of old houses in the last stages of decay. Fields of corn and oats stretch over the streets and squares where once were gaudy theaters and dance houses, gorgeous saloons and mammoth hotels. When the oil fever was high a half-acre of what is now waste pasture land was sold at a rate equivalent to $100,000 an acre. Over on the hill still lives old Mr. Copeland, who in 1865 refused an offer of $700,000 for his farm. Two years later he would have taken as many cents. He still owns it, and his daughter teaches school and supports the family. In all this there may be a lesson for speculators at Garfield to-day."

Melting Steel by Electricity.

Professor Siemens a short while ago made the following interesting experiment before a body of practical electricians: A number of broken pieces of steel were put in a properly arranged crucible, having a perforated lid, the two currents of the electro motor terminating in the upper and lower part of the crucible. In fourteen minutes the entire mass of metal was heated, turned red and liquefied. There was not a single bubble in the mass. The cost of fuel required for this apparatus is very much less than that which would be wanted if the fusion were effected by the direct application of the heat. A considerable saving may be consequently attained in steel works if this process be generally adopted.

THE GOODWIN GAS STOVE AND METER CO.

1012, 1014 and 1016 FILBERT STREET,

142 CHAMBERS STREET, NEW YORK. PHILADELPHIA. *126 DEARBORN STREET,* CHICAGO.

GAS AS FUEL.

Testimonials showing the Advantages of Gas for Cooking and Heating Purposes,

FROM THOSE WHO HAVE TRIED AND PROVED OUR STOVES AND FOUND THEM "GOOD."

First Prizes have been Awarded us, as follows:

One Gold Medal, Twelve Silver Medals, One Bronze Medal, Five Diplomas.

We herewith submit to Gas Companies and Consumers ADDITIONAL Testimonials to those presented in the preceding issue of the GAS LIGHT JOURNAL of July 3, 1882:

PHILADELPHIA, March 22, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—About nine months ago I purchased from you a "Sun Dial Gas Stove," and I have used it constantly ever since. In the summer months, the Gas Stove, superceding in great measure, the fire in the range, the *temperature* of the whole house was greatly reduced, and this I regard as one of the benefits of using the stove. There is an expense for gas, but there is also a saving in coal. In the morning the range is scarcely ever used for cooking purposes, summer or winter; and to me this is the greatest convenience, because (breakfast must be on the table precisely at 6) by striking a match THE STOVE IS IMMEDIATELY IN ORDER, and cooking two dishes at a time, so that in half an hour or less, breakfast for seven persons is prepared. My wife would not now be without it, and I never fail to recommend it.

I am, gentlemen, yours respectfully,
EDWARD MACHARG,
1304 S. 17th Street.

PHILADELPHIA, March 15, 1882.

TO THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—My wife desires me to say, your Gas Stove answers every purpose, bakes, roasts, boils and keeps warm, all articles needed for eight (8) in family, as good, if not better than any Coal Stove or Range in existence, our help are very sorry to give it up in the fall, and long to commence in the early summer; no dirt, dust or trouble in lighting.

Respectfully, J. H. CANTRELL, M. D.,
1000 South 2d Street.

PHILADELPHIA, March 21, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

The Gas Stove purchased from you has proven a household treasure, it is always ready at the touch of a match; does its work (all the cooking, baking, etc., for a family of four) to a charm, and we would not part with it. We do not notice the disagreeable odor caused by other gas stoves which we have used, and which is so annoying in a small kitchen. Another result is the freedom from the heat in the summer time, which is impossible to avoid in the use of a kitchen range. Very truly, yours,

JAMES S. SMYTH,
324 Christian Street.

PHILADELPHIA, March 17, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—I have been using the Sun Dial Gas Stove I got from you during the summer season, for the last two years, doing all the cooking, baking, broiling and washing with it, with entire satisfaction, and with trifling expense for gas. I prefer the gas stove for baking purposes to the Excelsior range which we have. Respectfully yours,

MRS. JOSHUA EVANS,
148 N. 15th Street.

PHILADELPHIA, March 25, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

DEAR SIRS:—Have had in constant use this winter the Sun Dial Gas Stove, with a reflector to heat a room of 20 feet square, and during the summer at my residence as a cook stove, and was perfectly satisfactory in each capacity. Yours,

GEO. C. LINCOLN,
1308 Chestnut Street.

PHILADELPHIA, March 30, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—I have used your Sun Dial Gas Stove and can recommend it as a first-class article. I would not be without it.

Most respectfully, H. E. BITTERLICH,
703 Market Street.

PHILADELPHIA, March 10, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

DEAR SIRS:—The Sun Dial Gas Stove which we bought of you in December last has given satisfaction—bakes, broils, boils, etc., to perfection. At the same time heats a good size room.

Yours, etc., MRS. A. E. GARDENER,
901 Franklin Street.

PHILADELPHIA, March 30, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—The Sun Dial Cooking Stove is the most complete article of the kind ever put in the market; would not be without one for twice the price; have used mine all winter and find it cheaper than coal. Wishing you success in their sale, I remain, Yours, very truly,

MRS. R. W. PETERSON.

PHILADELPHIA, March 18, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—It affords me great pleasure to recommend the Sun Dial Gas Stove. I consider that meats and fish cooked in the stove are far superior to those cooked by coal or wood. It gives me satisfaction in every particular.

Respectfully,
CHARLES P. KUCHLINE, M. D.

THE GOODWIN GAS STOVE AND METER CO., Philadelphia, New York and Chicago.

PHILADELPHIA, March 22, 1882.

THE GOODWIN GAS STOVE AND METER CO.,
1012 and 1014 Filbert Street,

GENTLEMEN:—Your favor to hand; about a year ago my wife purchased from you a "Sun Dial Gas Stove" and has given it a thorough trial. She pronounced it a wonder, doing well all that you recommended. She would not part with it for twice its cost. I cheerfully grant you the use of our name, if it will in any way benefit or advance the sale of the stoves.

Respectfully yours, A. J. REILLY,
3243 Sansom Street.

PHILADELPHIA, March 23, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

The Sun Dial Gas Stove purchased from you last summer, has given us the greatest satisfaction, as being one of the very best that ever came under our notice, its facility for cooking and baking being equal to the best range in any kitchen, which together with its economy of Gas, being far less than Coal used for the same purpose, recommends it as one of the pleasures and comforts of a Summer Kitchen. Very truly,

E. C. ELIAS,
656 North 11th Street.

PHILADELPHIA, March 24, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

DEAR SIRS:—We purchased of you May 27, 1880, a No. 5 Sun Dial Gas Cook Stove, that we have used for two years during the summer, and consider it to be a great saving of work, cost and dirt, with better results for summer cooking than either a range or stove burning coal.

Yours truly, J. C. RULON,
1313 Vine Street.

PHILADELPHIA, March 22, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

The Sun Dial Gas Stove purchased from you gives entire satisfaction. Everybody should have one for summer use. My wife is particularly pleased with its baking capacity. Yours, etc.,

W. C. BARRETT,
34 N. 39th Street.

PHILADELPHIA, March 20, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

DEAR SIRS:—In reply to yours of the 16th inst., I most cheerfully write as below giving you permission to use if you consider it to the point: Our experience in regard to the "Sun Dial Gas Stove," I can say without any hesitation, is of the most gratifying character. It is one of the most convenient articles that can be put in a kitchen. Our Sun Dial has been in use for nearly two years, and has never cost a cent for repairs. In point of economy, where ordinary care is used, it is cheaper than a range coal stove, and in convenience and comfort, especially in hot weather the Sun Dial Gas Stove in my opinion, stands unrivalled.

Yours, very truly, THOS. A DOWNS, M. D.,
209 N. 41st Street.

PHILADELPHIA, March 24, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTS:—In response to your inquiry about the "Sun Dial Gas Stove" purchased from you, I certainly must acknowledge its excellence and utility, for after a continuous use of over three years, have found it a most decided success as a cooking apparatus, and this opinion is based upon the daily appreciation of those who use it constantly. The consumption of gas in connection therewith is an expense that is more than recompensed by the saving in every other respect, and so it appears to meet every requirement. I cheerfully offer myself as one of your references, and privilege you to send any one wanting information to me, as I can convince them that the "Sun Dial Gas Stove" is simple, safe and satisfactory, and a saving institution in any household. Very truly, yours, etc.,

CHARLES H. DOUGHERTY,
1314 Chestnut Street.

PHILADELPHIA, March 16, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTS:—The Sun Dial Gas Stove that I purchased of you July 9, 1881, has been in constant use at my house since that date, and has far exceeded my expectations, and I cheerfully recommend it to all who wish an article in the Gas Stove line. Respectfully, GEORGE B. ZANE,
1008 S. 2d Street.

PHILADELPHIA, March 16, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—The Sun Dial Gas Stove purchased of you has given entire satisfaction. As far as baking and cooking is concerned, my wife thinks it preferable to the range; besides keeping the house free of heat, coal gas and dirt. I can cheerfully recommend it to any one desiring a durable and economical cooking arrangement for summer use.

Respectfully yours, MILES KING
1628 Francis Street.

PHILADELPHIA, March 20, 1882.

TO THE GOODWIN GAS STOVE AND METER CO.,

GENTS:—I have been using one of your "No. 7 Sun Dial Gas Stoves" in my family for the last two years, and it has given the utmost satisfaction. It does its work thoroughly and *in a better manner than a coal stove or range.* It boils, bakes, broils, toasts, and really does everything that a first-class stove or range can do. I believe it to be more economical than a coal stove, and for the convenience and comfort derived, I would not be without it. Wishing it every success, I am, Yours respectfully, MRS. CLARA POLE,
1522 Race Street.

PHILADELPHIA, March 29, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTS:—In answer to yours of the 21st, would say, that we have used your Gas Stoves during the whole of last summer and part of autumn. We are very much pleased with the same, for comfort, economy and effectiveness, it is all that you claim for it. We look upon it as indispensable.

Yours, HERMAN HAMBURGER,
1513 N. 10th Street.

2137 AUBREY PLACE, PHILADELPHIA.

MESSRS. W. W. GOODWIN & CO.,

DEAR SIRS:—The "Sun Dial" Gas Stove you sent me, I am glad to say, has proved an entire success. If my testimony is of any value to you, you are at liberty to use it. The decrease in the coal bill more than offsets the increase in the gas ditto. The cooking is excellent and uniform in its operation. No dirt or dust irritates the careful housewife, and Mrs. S. describes it a "real treasure." In my humble opinion any man who really wants to add to the number of allotted days of his better half, had better invest in a "Sun Dial" and save her worry and himself expense. Yours, W. H. SEYMOUR.

ADAMS HOUSE,
Opposite Michigan and Illinois Central Railroad Depots.
THOS. DAKIN, Proprietor.

CHICAGO, Feb. 27, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—The Sun Dial Gas Stove that I purchased of you has given entire satisfaction, and supercedes any other that is at present on the market. We have given it a thorough trial.

Respectfully yours, THOS. DAKIN, Prop. Adams House.

OFFICE OF SAMUEL MYERS & CO.
268 and 270 Madison St.

CHICAGO, Feb. 24, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—We are well pleased with the Gas Heating Stove we use in our store. We have had it in almost constant use, using steam only when it was required for other purposes in the building. We consider your stove neat, clean, and "A 1" in every respect, and trust you may sell a lot of them.

Yours respectfully, SAMUEL MYERS & CO.,
268 and 270 Madison Street.

CHICAGO JOURNAL OF COMMERCE,
Wm. Baker, Publisher,
No. 70 State Street,
CHICAGO, March 3, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—The cheerful Gas Stove purchased from you in October last, for use of *Journal of Commerce* office, has given the greatest satisfaction. It is wholly free from odor, the heat easily regulated, and has all the appearance of a clear burning coal fire without its attendant inconveniences. We can strongly recommend it. Yours truly,

JOURNAL OF COMMERCE,
70 State Street.

CHICAGO, ILL., Feb. 24, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

DEAR SIRS:—I have thoroughly tested the Sun Dial Gas Stove in my laboratory, and found it not only an excellent heater, but the handiest stove

THE GOODWIN GAS STOVE AND METER CO., Philadelphia, New York and Chicago.

for laboratory purposes I have tried. For chemical purposes it becomes necessary to use different intensities of heat, which can be modified on the Sun Dial to perfection. During the cold snap, my laboratory was well heated, and often the gas had to be turned off to allow the room to cool off.

Respectfully, J. C. HOOFMAN, M. D.,
161 Washington Street.

AMERICAN IRON WORKS—JONES & LAUGHLINS,
Lake, Canal and West Water Sts.

CHICAGO, Feb. 25, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—We have used during the winter and fall months one of your improved ventilating and reflecting gas heating stoves, and are glad to say it has given us entire satisfaction. It has been used in one of our offices where any other kind of heater would have been impracticable, and our shipping clerk is warm in its praise.

Yours respectfully, JONES & LAUGHLINS,
Lake, Canal and West Water Streets.

OFFICE OF VERGHO, RUHLING & CO.,
IMPORTERS,
138, 140 and 142 State Street,

CHICAGO, March 7, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTS:—We are using one of your No. 7 Gas Stoves in the lunch room of the young ladies, connected with our retail depot. We are perfectly satisfied with its workings, and cheerfully recommend it to any one needing a really useful and desirable and useful article. Our clerks have no more cold lunches, but, instead, they now have a well-cooked first-class dinner, and say they don't see how they did without the "Goodwin Gas Stove" so long. It should be in every well-regulated store.

Yours very truly, VERGHO, RUHLING & CO.,
138, 140 and 142 State Street.

CHICAGO, January 24, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

DEAR SIRS:—The Sun Dial you put in my office has proved equal to the representations made. Sorry I did not know of it sooner, so I could have enjoyed its benefits before. Very respectfully,

O. W. BARRETT,
120 La Salle Street.

CHICAGO, Feb. 25, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—I have been using one of your Gas Stoves since June, 1881, and have found it very convenient, and it seems to answer its purpose in every particular. Yours truly,

W. R. KING,
2108 Prairie Avenue.

CHICAGO, Feb. 23, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—Most cheerfully I recommend your Gas Stoves, having one in use myself in my family, and find only satisfaction to report on.

Respectfully yours, FRED. SOMMER,
2212 Archer Avenue.

CHICAGO, March 4, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—The Gas Cook Stove I bought of you I have used for the past six months in my lunch room, and take great pleasure in saying that it has given entire satisfaction. Its arrangement for roasting, I think, superior to any process with which I am acquainted.

Yours truly, M. H. PHILBRICK,
66 State Street.

CHICAGO, Feb. 24, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

The Sun Dial Gas Stove purchased of you about eight months ago has been in use ever since, and given entire satisfaction in all respects.

SCHLESINGER & MAYER,
State and Madison Streets.

CHICAGO, Feb. 24, 1882.

THE GOODWIN GAS STOVE AND METER CO.,

GENTLEMEN:—I would merely add to the numerous testimonials already received by you, that our gas stove gives perfect satisfaction. I would not be without it (especially in summer) for twice its value.

Respectfully, MRS. L. S. MAJOR,
2943 Vernon Avenue.

CHICAGO, Feb. 25, 1882.

THE GOODWIN GAS STOVE AND METER CO.

DEAR SIR:—You are at liberty to use my name as using and recommending your stoves. The two I have had proved satisfactory in every particular.

Respectfully, CHARLES C. CURTISS,
2011 Wabash Ave.

CHICAGO, March 4, 1882.

THE GOODWIN GAS STOVE AND METER CO.

DEAR SIRS:—About a year ago I purchased one of your gas stoves, about the first one you sold in the city after establishing your agency here. It works well, gives good satisfaction, and we can heat an ordinary sized room sufficiently for all purposes. We use it in the spring and fall before we start the furnace; I think that every family could use one to advantage. I prefer them to oil stoves on account of the odor. The expense of running it is very small, especially where you wish temporary heat.

Yours, truly, G. LASHER & SON,
125 S. Water Street.

CHICAGO, Feb. 28, 1882.

THE GOODWIN GAS STOVE AND METER CO.

GENTLEMEN:—In utility, cleanliness and rapidity, the Sun Dial Gas Stove is unequalled in all the purposes for which a cooking stove is needed.

Respectfully, MRS. FRED. B. CLARKE,
44 Ada Street.

CHICAGO, Feb. 27, 1882.

THE GOODWIN GAS STOVE AND METER CO.

DEAR SIRS:—With pleasure we inform you that the No. 2 heater gas stove bought of you some time ago has worked satisfactorily.

Respectfully, BRACHVOGEL, PRESS & CO,
261 Wabash Ave.

CHICAGO, Feb. 24, 1882.

THE GOODWIN GAS STOVE AND METER CO.

GENTLEMEN:—I am now using one of your small size Gas Stoves and like it very much. It heats well, and is always neat and convenient.

Respectfully, M. R. JOHNSON,
Short-hand and Commercial Institute.
88 La Salle Street.

CHICAGO, March 1, 1882.

THE GOODWIN GAS STOVE AND METER CO.

I purchased one of your gas stoves about nine months ago, to use at home. My wife is well pleased with its working, and would not be without it. As a summer cook-stove, we think it has no superior, and for winter use it is equally desirable, being always ready for instant use, night or day.

ANDREW CUMMINGS,
13 E. Van Burlee street.

CHICAGO, Feb. 25, 1882.

THE GOODWIN GAS STOVE AND METER CO.

DEAR SIRS:—Your favor of the 21st inst. received, asking for our opinion of the Sun Dial Gas Stove. In reply, we would say that it has proved very satisfactory and fully up to your recommendation. We strongly recommend it to the public. Very respectfully, CLARKE & CO.,
125 La Salle Street.

CHICAGO, Feb. 25, 1882.

THE GOODWIN GAS STOVE AND METER CO.

GENTLEMEN:—The "Cheerful" heating stove purchased of you last fall has proven entirely satisfactory, and its merits are even more than you claim. A tidy housekeeper will appreciate its cleanliness and convenience, and in the matter of economy—in my case, it has been less expensive than the use of coal.

Respectfully, J. E. HALL,
266 Wabash Ave.

CHICAGO, Feb. 27, 1881.

THE GOODWIN GAS STOVE AND METER CO.

DEAR SIRS:—The No. 7 Sun Dial Gas Stove purchased in August last, continues to be a great favorite, its use has been in light housekeeping, still we have tried it in many ways, cooking anything we have wanted, and its working has been perfect, more than realizing our greatest expectation. The cost of gas for fuel we are satisfied has been less than coal would have been, and the trouble saved, with its cleanliness in use, is a very great recommendation. Respectfully yours,

C. H. CHURCH,
374 Oak Street.

THE GOODWIN GAS STOVE AND METER CO., Philadelphia, New York and Chicago.

CHICAGO, March 9, 1882.

THE GOODWIN GTS STOVE AND METER CO.

I purchased one of your "Sun Dial" Gas Cooking Stoves from you last summer, and take great pleasure in bearing testimony to its merits. My wife says it is a perfect jewel, and should be in the possession of every housekeeper. It is better than you claim for it.

Yours, very truly, JOHN R. FLOYD,
American Express Company.

CHICAGO, Feb. 27, 1882.

THE GOODWIN GAS STOVE AND METER CO.

The "Sun Dial" which I purchased of you last summer, with the idea of only having a summer cooking stove, in order that I may do away with my brick range and thereby keep my house much cooler, has proved so convenient and cooks so nicely, and at the same time costs no more to run than my range. I have used it almost constantly ever since, both during summer and winter. It broils fish and meats, bakes biscuits, bread, and pastry much better than the range, and cooks, roasts quite as well as the range and of course is much less trouble to run, as my cook has no coal to bring in or ashes to carry out. If I could not buy another I would not sell it at any price. If any of your purchasers want to know the merits of your "Sun Dial" cooking stove send them to me. Respectfully,

S. G. MYERS,
2613 Michigan Ave.

CHICAGO, Feb. 24, 1882.

THE GOODWIN GAS STOVE AND METER CO.

MY DEAR SIR:—In replying to yours of the 20th inst, I would say, that the 10-inch Ventilating and Reflecting Gas Heating Stove purchased from you in October last, has given me excellent satisfaction. The heat is soft and pleasant, there is no perceptible odor, and the consumption of gas is trifling. I consider it particularly adapted to office use, or for heating a bath-room, drawing-room or nursery. Very truly, yours,

CHARLES D. GAYLORD,
236 S. Water Street.

CHICAGO, March 15, 1882.

THE GOODWIN GAS STOVE AND METER CO.

GENTLEMEN:—We having used one of your No. 10 Sun Dial Gas Cooking Stoves since September 1, 1881, we take pleasure in expressing our satisfaction. We use the No. 10 Sun Dial especially for oysters. We make stews in one and one-half minutes. We fry, broil, roast and bake in as quick a time as we can on our large range. For cleanliness it has no equal, the cost of gas is not as much as coal. We must actually say, we could not get along without it. Wishing you the fullest success for the Sun Dial, we remain,

Respectfully yours, HEINZ & LANGUS,
Restaurant and Oyster House,
122, 124 and 126 S. Clark Street.

CHICAGO, Feb. 22, 1882.

THE GOODWIN GAS STOVE AND METER CO.

I have in my house one of your Gas Cooking Stoves. I could not very well do business without it, for I am always in a hurry for my hot cup of coffee in the morning with a piece of a toast and some warmed up potatoes, etc., and if I had to wait till the girl got the hard coal stove heated up to a cooking heat, I would always be late to business. In the summer season they are a luxury, both as to economy and convenience; it only heats up itself and not the entire house. A coal cooking stove would necessarily have to do everything. Very respectfully,

A. BALLARD,
329 Michigan Ave.

CHICAGO, Feb. 23, 1882.

THE GOODWIN GAS STOVE AND METER CO.

GENTS:—Four months ago when we purchased a Sun Dial Gas Stove, you then asked us to let you know how we would be pleased with the workings of said stove. We have taken all this four months to ascertain, and now let you know that we are perfectly pleased with the result; as you are aware we use the stove for the heating of small rooms, in which we dry our cigars. It is well adapted for the purpose. Respectfully,

H. B. FRANKLIN & CO.

CHICAGO, Feb. 24, 1882.

THE GOODWIN GAS STOVE AND METER CO.

In reply to yours of 16th ult., we take pleasure in stating the 5 A. Sun Dial Gas Stove purchased by us of your Co. last October has given us eminent satisfaction. Yours, respectfully,

G. M. MUNGER & CO.
1345 and 1347 Wabash Ave.

CANTERBURY VARIETIES, CHICAGO,

THE GOODWIN GAS STOVE AND METER CO.

DEAR SIRS:—The Sun Dial Gas Stove that I purchased of you some time since has been in constant use in my restaurant. I say of it without hesitation it is the handiest stove I ever used. It is always in working order at any hour, day or night. I can cook a stew inside of two minutes, and in fact, it has never failed in any operation I have heretofore tried upon it. I most cheerfully recommend it to all persons using gas, as it is convenient, portable and safe. There is no kindling wood to chop and no coal to carry, and for cooking, your gas costs you at the rate of coal at $3 per ton or less. Trusting that this testimonial may be of benefit for the sale of your really valuable article. I remain, Respectfully,

JOS. A. MOLL,
124 W. Madison Street.

CHICAGO, Feb. 25, 188'.

THE GOODWIN GAS STOVE AND METER CO.

DEAR SIRS:—I have had in use since last May, one of your No. 7 Sun Dial Gas Stoves in my kitchen, a three flat-iron heater in my laundry. During the summer, not an ounce of coal, wood or coke was burned in my house for any purpose. All cooking and laundry work was done easily, promptly and satisfactorily by the gas stove and iron heater, at less expense for gas than for coal and kindling necessary to run a range. The flat-iron heater was used under the boiler, on wash-days, by adding a simple support for the boiler at an expense of only thirty-five cents. I have taken pleasure in showing and recommending the stove, etc., to my friends, and many of them have purchased. Yours truly,

T. WATSON.

CHICAGO, March 11, 1782.

THE GOODWIN GAS STOVE AND METER CO.

GENTLEMEN:—The Gas Cooking Stove No. 5 A, which I purchased of you some months since, has given the most perfect satisfaction, and we consider it quite indispensable. It cooks everything with a speed and thoroughness quite astonishing, at an average cost of $4 per month. We would not part with it on any account. Very respectfully,

E. B. SQUIRE,
3766 Lake Ave.

CHICAGO, March 10, 1882.

THE GOODWIN GAS STOVE AND METER CO.

DEAR SIRS:—In answer to your request, I will state that several months ago I bought one of your Sun Dial Gas Heating Stoves for the purpose of warming a large bath-room. It has proved entirely satisfactory, and I take great pleasure in testifying to its efficiency in fulfilling the requirements for which I bought it. Yours truly,

WM. R. PAGE,
1235 Wabash Ave.

CHICAGO, Feb. 23, 1882

THE GOODWIN GAS STOVE AND METER CO.

DEAR SIRS:—Yours of the 16th inst. received, in regard to the Gas Stove. I am pleased to say it has given entire satisfaction. We have one of the smaller ones, and yet we can cook enough for our family of four on it very nice, and in about the same time it would take to make a fire. In the summer especially I find it of great benefit, as it does away with the heat and worry of another stove. I would not be without the stove for a great deal.

I remain, yours truly, MRS. H. C. BOHNE,
750 W. Madison Street.

CLEVELAND, April, 1882.

THE GOODWIN GAS STOVE AND METER CO.

DEAR SIRS:—Having in my restaurant, 320 Euclid ave., one of your No. 8 A, Sun Dial Gas Cooking Stoves, for Broiling it has no equal, always ready, losing but little time in getting an order, doing Roasting in same manner, also, all cooking to be done on any range, getting rid of dust from ashes or smoke. It is the most complete stove in every respect I ever used.

Respectfully. E. HEYSE,
320 Euclid Ave.

CLEVELAND, April, 1882.

THE GOODWIN GAS STOVE AND METER CO.

SIRS:—Having used in my restaurant, No. 5 Frankford street, one No. 8 A., also one No. 8 Sun Dial Gas Cook Stove, I find them not only economical, but doing the cooking in better style and in less time getting rid of the smoke, dust and ashes of Coal Ranges, would not be without them for any consideration. MOLITOR & CO.

CLEVELAND, March, 1882.

THE GOODWIN GAS STOVE AND METER CO.

I have been Col. Wm. H. Harris' cook for some time, have been cooking on an 8 A. Sun Dial Gas Cook Stove since July, 1881, and getting up on it five course dinners. It gives entire satisfaction in every respect, doing the cooking quickly; would not like to cook on any other, especially in hot weather as it leaves the House cool and comfortable.

ANGELO ESOAD.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

Editor—G. WARREN DRESSER.
Manager—C. E. SANDERSON.

PUBLISHED ON THE 2ND AND 16TH OF EACH MONTH
At No. 42 Pine Street, New York.

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LIGHT, HEAT, STEAM, WATER-SUPPLY,
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AND GENERAL SCIENCE.

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WEDNESDAY, AUGUST 2, 1882.

Viscosity of Gas.

Brooks concludes from his experiments upon the viscosity of gas in a nearly perfect vacuum, that some of the molecules may traverse more than a hundred times the mean distance of their ordinary course, and that they may also acquire a corresponding augmentation of the mean velocity before being stopped by collisions. From some of the phenomena he infers that the gaseous and ultra-gaseous states succeed each other in an insensible manner, so that at a given moment we may be able to perceive, at the same time, the phenomena which are produced by the gas and by the ultra-gas. The experiments of Tresca and Andrews have shown that the same fact is true in the passage between the solid and the liquid, and between the liquid and the gaseous states—*Ann. de Chim. et de Phys.*

Gas Stocks.

Quotations by G. W. Close Jr., Broker and Dealer in Gas Stocks.
(with W B Scott & Co.,)
34 PINE STREET, NEW YORK CITY.

AUGUST 2, 1882.

☞ All communciations will receive particular attention
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid.	Asked
Gas Co.'s of N. Y. City.				
Central	$466,000	50	70	75
Harlem	1,800,000	50	94	98x
" Bonds	170,000			103
Manhattan	4,000,000	50	220	225
Metropolitan	2,500,000	100	177	182x
" Bonds	658,000	..	107	110
Mutual	5,000,000	100	94	97
" Bonds, go'd.	900,000	1000	100	104
Municipal	1,500,000	100	190	195
" Bonds	750,000		106	110
New York	4,000,000	100	115	118
Northern	270,000	50	—	100
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	105	107
Citizens	1,200,000	20	65	70
" S. F. Bonds.	320,000	1000	105	107
Fulton Municipal	3,600,000	100	75	80
Peoples	1,000,000	10	40	45
" Bonds	290,000	.	104	107
" "	250,000	...	78	90
Metropolitan	1,000,000	100	62	65
Nassau	1,000,000	25	50	55
" Ctfs.	700,000	1000	93	96
Williamsburgh	1,000,000	50	57	60
" Bonds	1,000,000	...	100	101
Richmond Co., S. I.	300,000	50	70	75
" Bonds	40,000	—	—	—
Out of Town Gas Companies.				
Buffalo Mutual, N.Y	750,000	100	—	75
" Bonds	200,000	1000	95	100
Citizens, Newark	918,000	50	—	—
" " Bds.	124,000	—	105	10
Chicago Gas Co., Ills			125	—
Cincinnati G.& C. Co.			178	180
Consolidated, Balt.			42	43
Bonds			107	—
East Boston, Mass	220,000	25	122	128
Hannibal, Mo	100,000	100	95	100
Hartford, Conn	700,000	25	140	144
Halifax N. S	400,000	40	148	150
Hamilton, Ontario	150,000	40	117½	
Jersey City	750,000	20	155	160
Jacksonville, Ill	120,000	50	100	...
Lewistown Maine	400,000	100	—	100
Laclede St Louis Mo.	1,200,000	100	112	117
Montreal, Canada	2,000,000	100	168	170
New Haven, Conn		25	132	—
Oakland, Cal			32	33
Peoples, Jersey City		...	75	80
" " Bds.			...	...
Pittsfield, Mass			120	130
Rochester, N. Y		50	70	80
Wilmington, Del		50	174	...
Yonkers		50	30	32
St. Louis Missouri	600,000	50	250	254
San Francisco Gas-Co., S. Fr'sco Cal.			68	69
Toledo, Ohio			95	97
Troy, Citizens	600,000	100	—	—
Washington, D. C	1,500,000	20	185	200
" Scrip	375,000	15	200	206

☞ The following dividends are payable Aug. 1: Manhattan, 5 p.c.; Metropolitan, 6 p.c.; Municipal 4 p.c.; Harlem 3 p.c.

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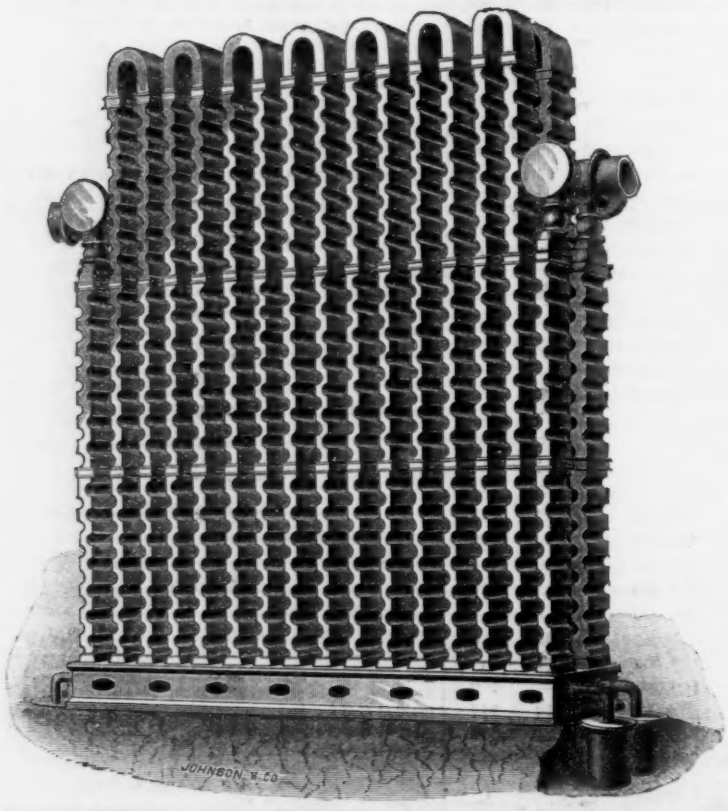

We desire to draw the attention of the gas community to the merits of the SINUOUS FRICTION CONDENSER. Companies intending to introduce new condensers into their works will do well to confer with us and examine plans and estimates before contracting for any other pattern. The FRICTION CONDENSER is now in use at the gas works located in the following places:

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GAS AND WATER MACHINERY

OF THE MOST APPROVED PATTERN.

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Orders from Gas and Water Companies promptly attended to.

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FOR SALE CHEAP.

A Lot of Miner's Lamps.

STREET SIZE.

Are in good order, and will be sold in quatities to suit. Address NEW YORK & NEW JERSEY GLOBE GAS LT. CO., Limited, 554-2t 152 Broadway, N. Y. City.

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MINER'S PATENT STREET LAMPS.

Are adapted for use of Streets, Parks, Depots, Ferries, & Private Grounds.

WITH POSTS OR BRACKETS.

Jacob G. Miner,

MORRISANIA, N. Y. CITY,

CIRCULAR TO GAS LIGHT COMPANIES.

BRANCH OFFICE OF THE STRONG GAS FUEL AND LIGHT COMPANY,
CORNER BROADWAY AND MAIN STREET, YONKERS, July 2, 1881.

The YONKERS FUEL GAS COMPANY is now in successful operation, manufacturing Water Gas by the STRONG PROCESS, for HEAT, POWER, and LIGHT.

It has about two and a half miles of mains already in use through the heart of the city of Yonkers, and is supplying gas for cooking, heating, and various industrial purposes.

The problem of a purely fuel gas is at length practically solved, and is a complete success. That it must speedily go into universal use is apparent to everyone.

Gas Light Companies are cordially invited to visit Yonkers and inspect this new system, which, if electricity *should* eventually drive them out of the field of illumination, will open to them another field still more vast and fruitful, and from which they never can be dispossessed. The Westchester Gas Light Company of the city of Yonkers employes the Lowe Process for making its gas. Here, then, can be seen, side by side in business competition, the Strong and the Lowe against the Motay and the old coal gas methods, and each observer will be enabled to form his own opinion as to their relative power and value. The STRONG GAS FUEL AND LIGHT COMPANY is the proprietor for the State of New York of the Strong Patents, five in number, and of the Lowe Patents, two in number. All applications for licenses or for information should be addressed, as above, to

R. W. VAN PELT, *President of the Company,*
And also President of the Yonkers Fuel Gas Co., and of the Westchester Gas Light Co.

Announcement.

BY ARRANGEMENT WITH

JOHN METHVEN,

of the London Gas Lt. Co., inventor of the

NEW STANDARD PHOTOMETER,

THE SOLE AGENCY FOR THE UNITED STATES IS VESTED IN THE UNDERSIGNED.

GEO. SHEPARD PAGE,

Wall Street, New York.

G. W. DRESSER, C.E.,

Member American Society Civil Engineers.

CONSULTING ENGINEER

ON ALL MATTERS PERTAINING TO

Gas Manufacture.

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GAS BURNERS,

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No. 284 North Eighth Street, Philadelphia.

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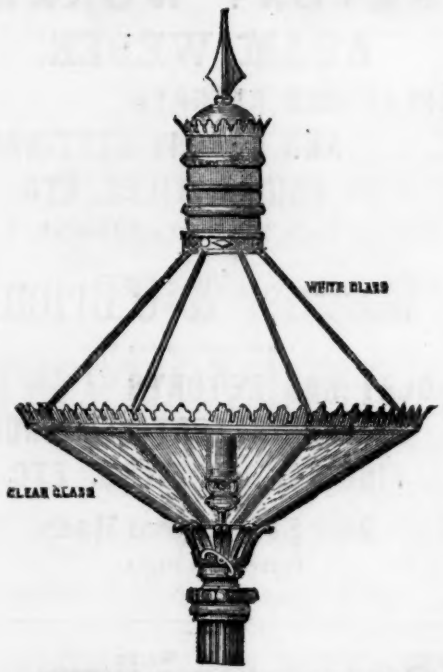

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THE ONLY BURNER FOR WHICH A GOLD MEDAL WAS AWARDED.

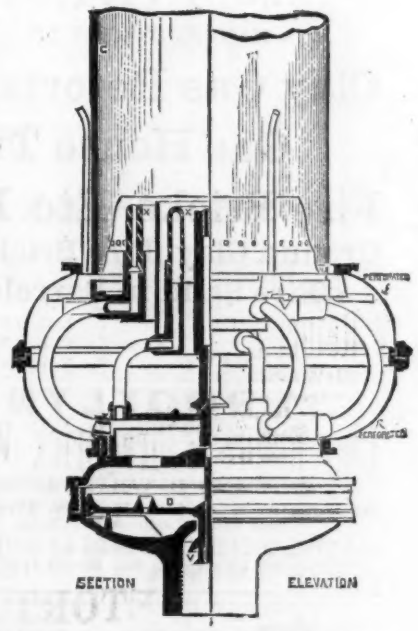
List of Sizes.

Size.	Candles.	Size.	Candles.
A (15 holes)	10	HH (60 holes)	29½
B (18 ")	12	J (38 ")	29
C (21 ")	14	JJ (38 ")	30½
D (24 ")	16	K (42 ")	31
E (27 ")	18	KK (42 ")	34
F (30 ")	20	NN (75 " 2 rings)	50
G (33 ")	24	100 Candles (2 rings)	100
GG (33 ")	25½	200 " (3 ")	200
H (36 ")	28	400 " (4 ")	400

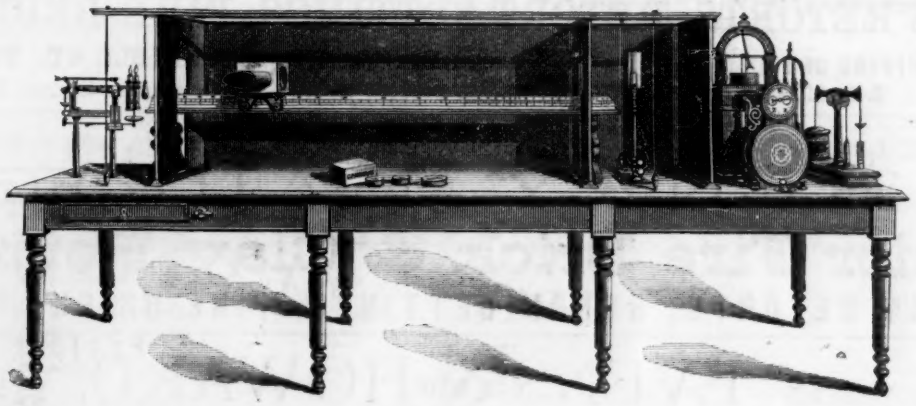
SUGG'S LANTERNS,

WITH DOWNWARD DRAUGHT AND VENTILATING CHIMNEY.

Size.	Price.	Size.	Price.
50 Candle Lantern	$25.00	200 Candle Lantern	$65.00
100 Candle Lantern	37.50	400 Candle Lantern	95.00



SUGG'S PATENT STEATITE FLOAT LAMP GOVERNOR BURNERS FOR STREET LIGHTING.



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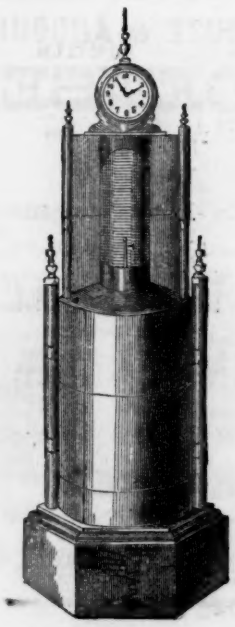

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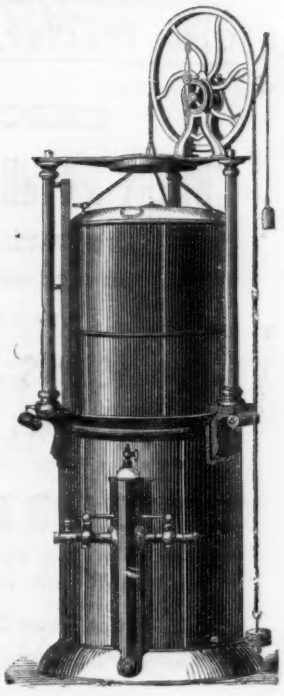

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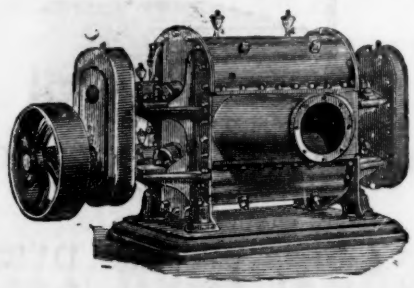

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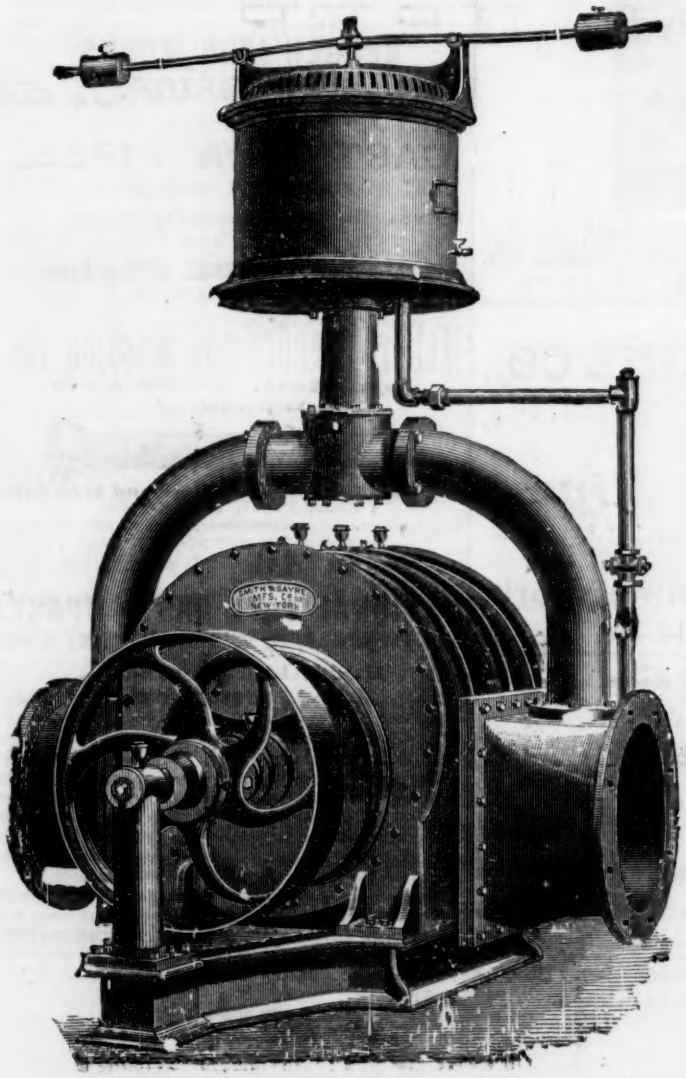

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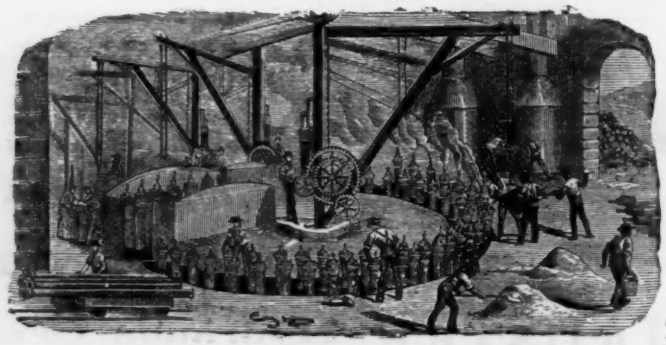

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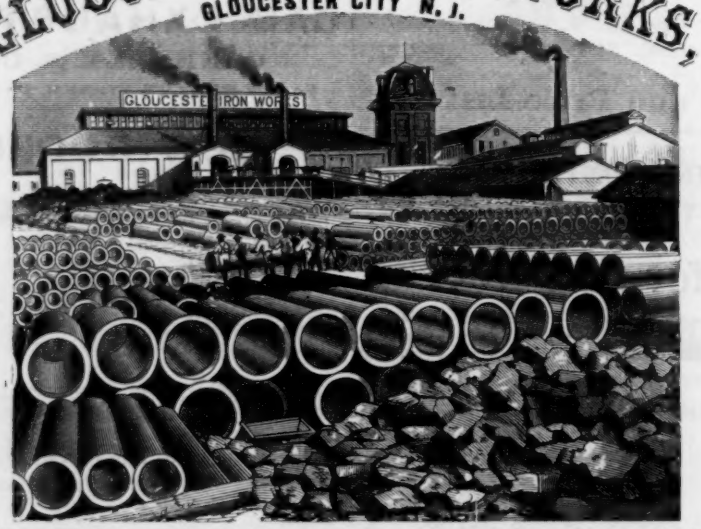

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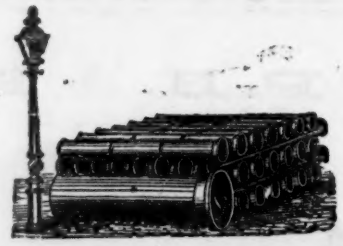

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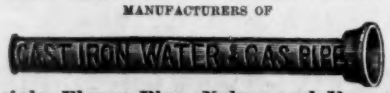

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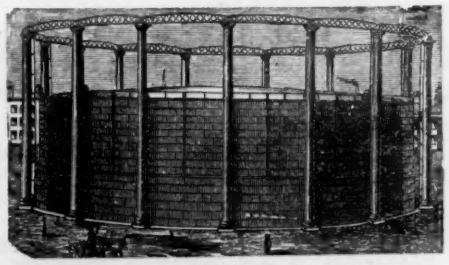

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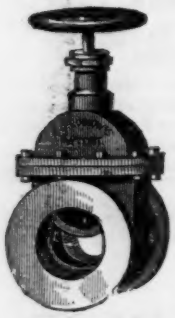

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N. LEVASSEUR, Inspector."

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SECTION II.—Duration and mode of testing in London, sulphuretted hydrogen, ammonia, sulphu compounds. Preparation of solutions. Fitting up. To set the apparatus at work. Analysis.

SECTION III.—Ammonia. Sulphuretted hydrogen. Carbonic acid. The Cooper's Tube, or Eudiometer. To calculate weight of sulphur. Harcourt's color test. A rapid and accurate methodof estimating sulphur in coal gas. Specific gravity. To find the specific gravity of dry gas. To correct the bulk and find the weight of gas.

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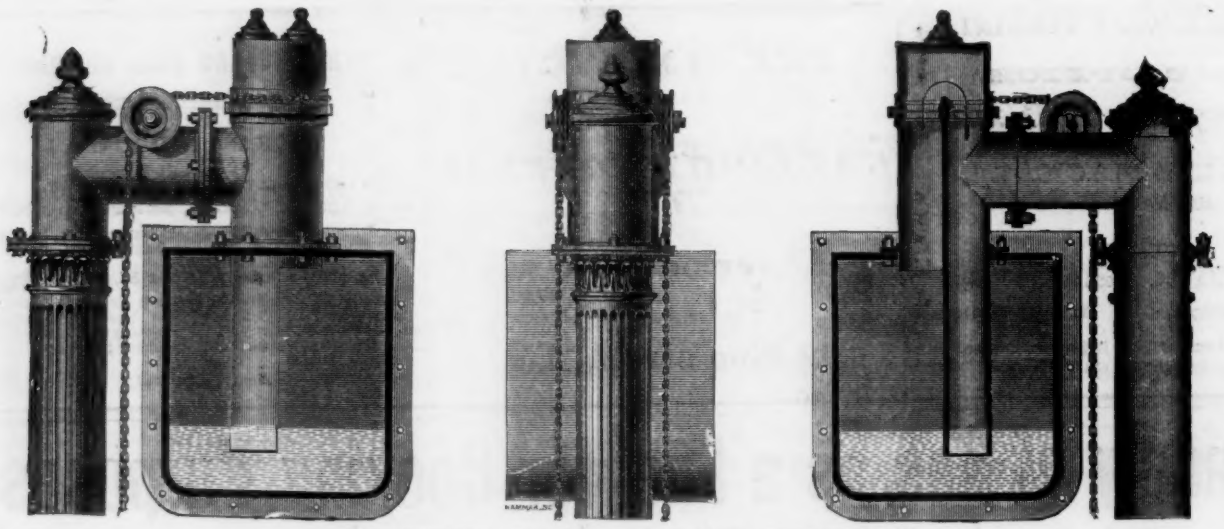

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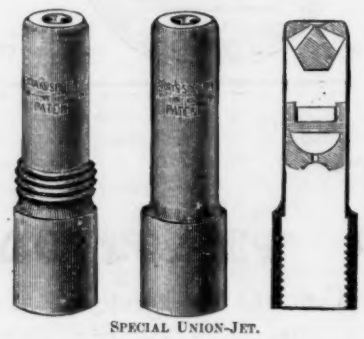

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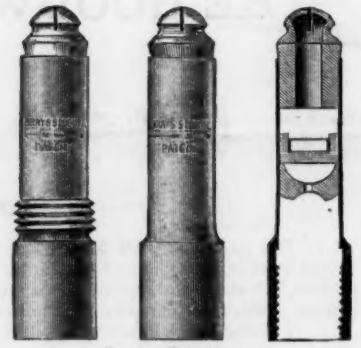

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" " " No. 5.....	.50	4 24	16.97	20.01	4.00
" " " No. 4.....	.60	3.49	12.58	18.02	3.60
" " Union Jet No. 7.....	.50	4.84	19.13	19.76	3.95
" " " No. 6.**.....	.55	4.32	17.10	19.79	3.95
" " " No. 5.**.....	.60	4.14	15.65	18.90	3.78
" " " No. 4.....	.55	3.58	12.04	17.81	3.56
" Regulator Union Jet No. 7.....	.50	4.99	17.69	17.72	3.54
" " " " No. 6.....	.50	5.18	17.63	17.01	3.40
" " " " No. 5.....	.60	4.37	13.71	15.68	3.13
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